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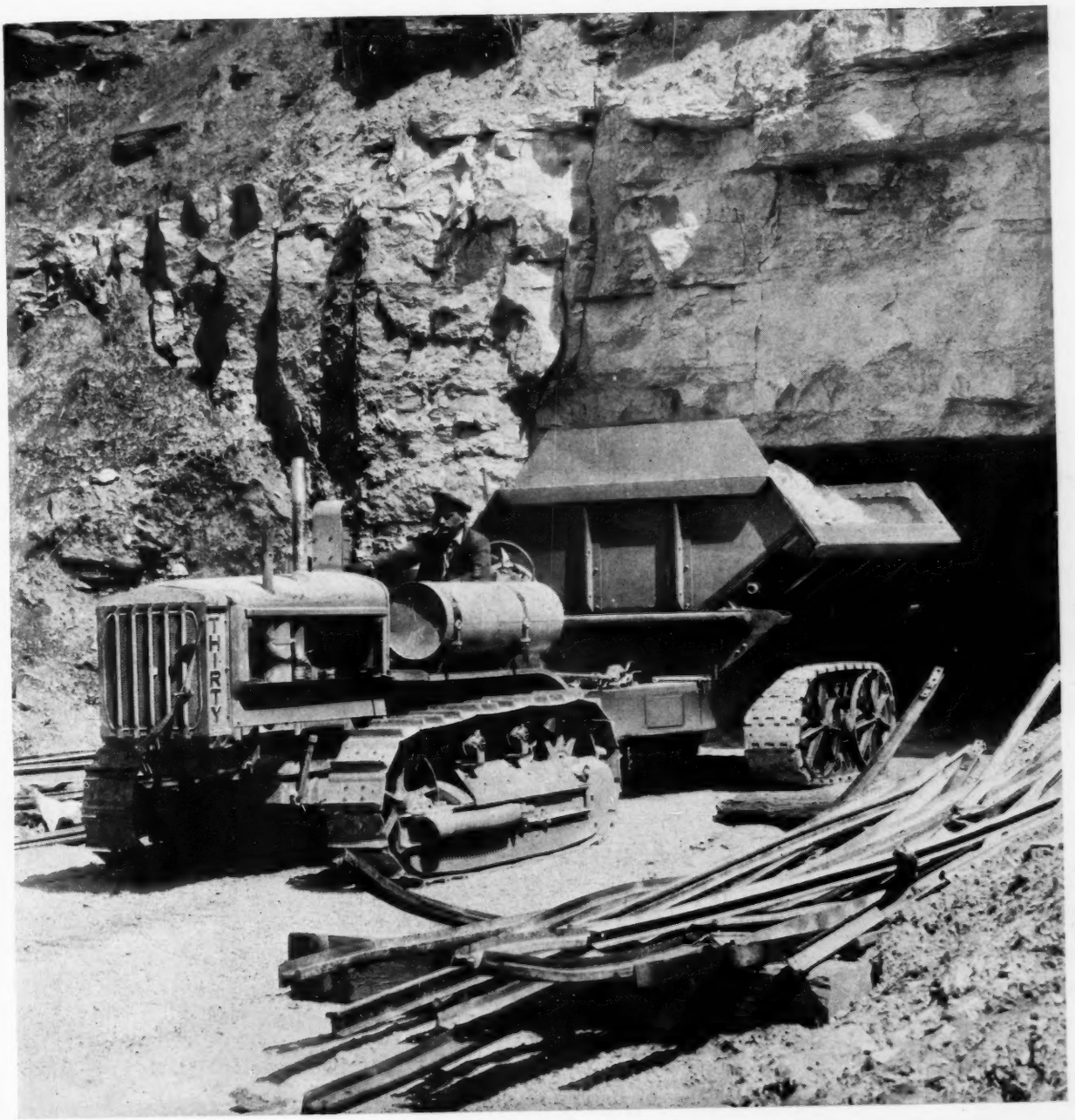

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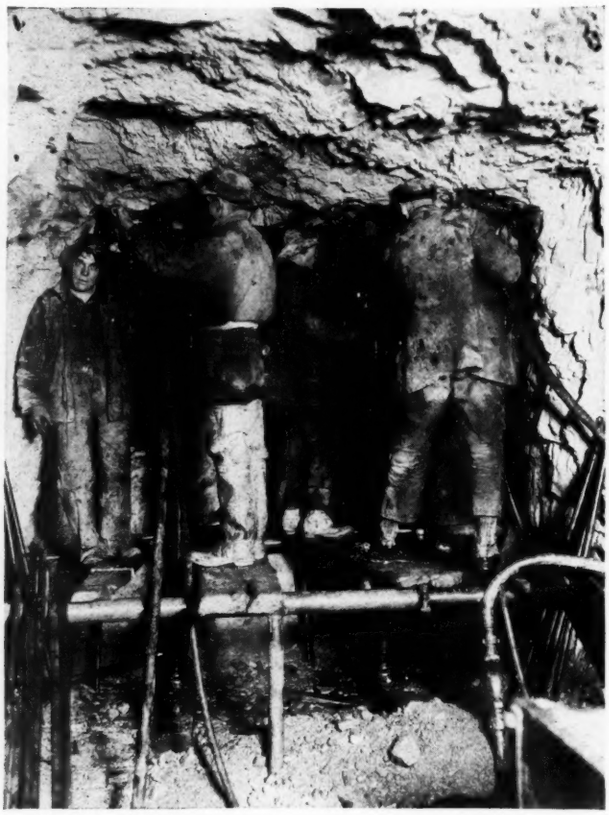

(*Above*) *Miners drilling in the Hooper Tunnel of the Crescent Mine.*
(*Below*) *Entrance to the Kellogg Tunnel—the main tunnel of the Bunker Hill Mine.*

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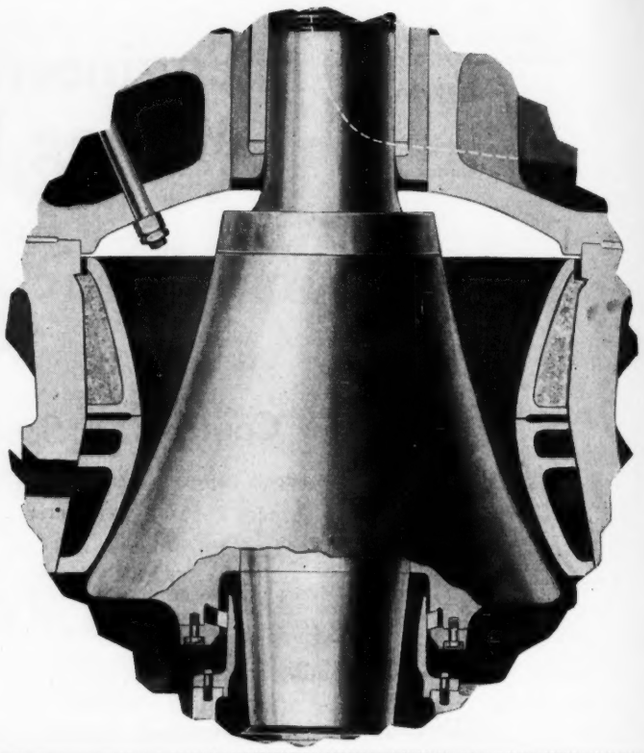

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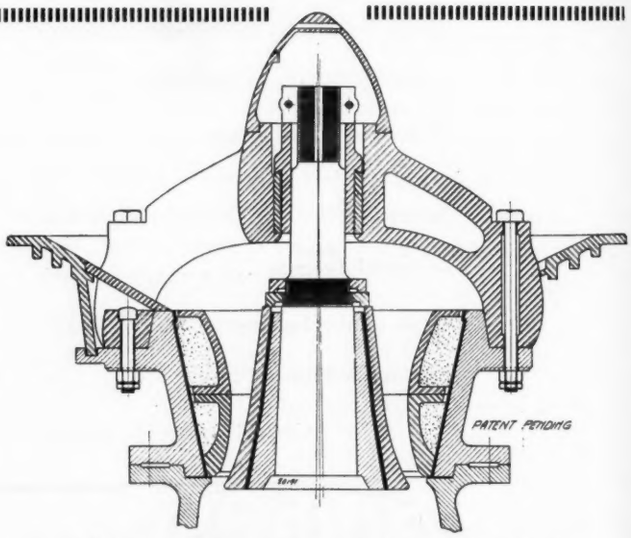

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Engineering and Mining Journal

September 14, 1931 A. W. ALLEN, *Editor* Vol. 132—No. 5

Power Developments Stimulate Copper Consumption

THE STEADY CONSUMPTION of copper by the utility companies has been one of the bright spots in an otherwise dull market. This is even more encouraging when the great potentialities of the power field are considered. Mr. J. S. Tritle, general manager of the Westinghouse company, in a recent statement in *Iron Age,* predicts a power consumption of 172 thousand million kilowatt-hours in the United States by 1940, compared with 91 thousand million for 1930. This, he assures us, is a conservative estimate. Of 29 million American homes, he continues, about 20 million are electrified; only one million, however, may be classified as adequately equipped electrically. Average annual consumption per home is 550 kw.-hr., whereas the potential consumption is 3,000 to 5,000 kw.-hr. Of the farms, only 10 per cent, and of the steam railroads only 1 per cent, are electrified. Electrification of the Pennsylvania Railroad between New York City and Washington, D. C., now under way, is a $150,000,000 project.

An interesting development of later years—destined, without doubt, to stimulate per-capita consumption of electric power—is the tendency toward consolidation of smaller power systems into larger aggregates, with distribution of power through far-flung networks. High efficiency, even distribution of load, freedom from local disturbances, better regulation of water supply, independence of local shortage are among the advantages gained. An example of this is the linking of power plants in the Lower-Rhenish lignite fields and hydro-electric plants in the Alps by means of a 500-mile transmission line, operating at 220,000 volts. England formerly had 400 steam-power plants. About three-quarters of these are now being abandoned, and the generation of power will be concentrated in the remaining one hundred, combined into an extensive system, distributing power over the entire country through a main line, at 130,000 volts. The new development in the Irish Free State, embracing the entire state, has attracted much attention during the last two years. In France, plans are considered to link the large hydro-electric plants in the mountainous regions of the country by a network with center in Paris. Extensive combinations of individual plants scattered throughout Sweden have been partly completed. Plans have been discussed to tie some of the larger units on the Continent to the Norwegian network.

Rational developments of this nature, aiming to place cheap electric power within the reach of all, are of vital interest to the copper producers. Man's dependence on power is becoming more and more accentuated, and efforts to supply this demand will furnish an increasing outlet for the red metal.

Unintelligent Criticism Should Be Ignored

AN ENGINEER in charge of the operations of an important and well-known mining property writes that the mill, recently rearranged, is giving a statisfactory extraction, but that the publication of details would cause some persons to wonder why this or that was done, ignoring the fact that the problem was to use much of the equipment in place and to squeeze in new units where space could be found. Our reply deprecated a silence that might be interpreted as an admission of technical inferiority, for no other reason than because some superficial critics do not recognize the ultimate net advantage to stockholders by the procedure adopted in this instance. Our letter continued: "A much more difficult task is to do what you have done than to order a new and up-to-date plant. Those who have shown ingenuity in milling arrangements, under adverse conditions, and have succeeded in obtaining a satisfactory extraction, constitute the backbone of the industry and the hope for its longevity." Members of the operating staff of a mining property who have faced two alternatives—reconstruction at small expense or shutdown—and who have engineered worthy improvements in technique without involving spectacular expenditures, will always find a sympathetic and appreciative andience among their confrères. Such work makes and enhances personal and professional reputations.

Building With Metals Offers Great Opportunities

AN ENCOURAGING SIGN of late years is the vigorous effort of the non-ferrous metal producers to create new markets for their products. Most of this activity began during the period of post-War depression, when accumulated stocks of metals had to be marketed. Similar conditions now are acting as a spur to even more concentrated effort.

Many splendid results of this activity are evident today, such as the success of International Nickel in creating peace-time markets for metal formerly used principally in armament; the increased use of copper and brass pipe by the building industry, a result of educational work conducted by the copper producers and fabricators; the development of zinc die casting; the widespread use of rust-resisting metals in roofing, in vertical structures, and in exterior and interior trim.

Invasion of the building field is now focusing attention on the great possibilities in the use of metals

as main structural media, rather than for auxiliary use only. Striking advantages in construction are foreshadowed. Houses, superior in many respects to the present types of dwellings, and at a lower cost, should be made available by mass production methods adapted from existing technique. An all-metal house has been exhibited in the United States. In Europe, where greater progress has been made, such houses are already in use.

Any change as radical as the one proposed cannot be effected in a moment. Many years of effort may be required before satisfactory response is evident. The public is hard to convince that opportunity offers, and much conservatism and resistance to change must be overcome before general acceptance is secured. One of the principal obstacles will be the objection to standardization. Most people have a desire to see a certain amount of individuality expressed in their homes. Modern city development, especially in the less expensive class, is frequently criticized for the prevailing tendency to build large blocks of houses of standard types.

Fortunately, a variety of metals may be used, such as copper and its alloys, aluminum, zinc, lead, and the "stainless" alloys. Many colors and finishes are also available. The consumer should therefore have good opportunity to display individuality and to avoid the monotony of extreme standardization. With this fact in mind, metal producers should concentrate their efforts to promote building with metal, rather than giving sole attention to their own particular metal or brand. When the natural resistance to such a new type of building material is overcome, a field of vast possibilities will have been opened up, with opportunities for all.

Zinc May Have a Promising Future

CONCERN about the status of zinc is frequently voiced, and pessimistic statements have been made to the effect that full recovery from the present unfavorable position will not be accomplished in many years. The situation, however, is not without promise. A metal possessing so many valuable properties as does zinc cannot long be left begging for opportunities. The present difficulties are the result of a combination of unfortunate circumstances, all of which are temporary. When the somewhat painful process of adjustment has run its course, the producers should again operate at a fair profit.

One of the bright spots in the picture is the remarkable progress made in the metallurgy of zinc during the last fifteen years, a progress eclipsing that made in any other branch of non-ferrous metallurgy. Most spectacular is the development of the electrolytic processes of reduction, which have made possible the treatment of ores formerly of little or no value, and the production of a metal of high purity—an advantage for manufacturers of zinc and brass products.

The successful development of new methods of reduction has also had a stimulating effect on the older distillation process. Notable improvements have been made in simplifying technique and raising the quality of the product. Far from becoming obsolete, as some enthusiastic champions of the newer method sometimes have claimed, the distillation process is proving itself capable of holding its own. As the situation appears today, each of the two processes has its distinct field, and the choice between them will depend largely on the nature of the ore to be treated, the cost of power and fuel, recovery of byproducts, and factors of similar nature.

Remarkable success has also been achieved in increasing metallurgical recovery by each process. Furthermore, secondary processes for the retreatment of slag, flue dust, and other byproducts have added to overall recovery. Among these are the Waelz volatilization process, the Anaconda slag-fuming process, and the ammonia leaching process for zinc oxides.

Statistics indicate that the American producers have met the present glut of the zinc market with drastic curtailment in output. Similar restraint has not always been evident in other countries. Recent developments, however, offer promise that a more cooperative policy will be adopted. If the present adversity also results in intelligent long-time-planning to the same extent that it has spurred effort toward technical proficiency, the future will be bright.

Flotation as a Preliminary to Cyanidation

RECENT TRENDS in the metallurgy of gold indicate a willingness to abandon local precedent when an alternative procedure promises better results. In this respect the industry is much more open minded than it was a decade or so ago, when any system other than all-slime cyanidation was considered passé.

The ore from one large gold mine was of such a nature that 86 per cent of the gold was concentratable in about 7 per cent of the tonnage; yet sliming in cyanide was adopted because an almost complete extraction was obtained thus in laboratory tests. After about fourteen years a reversal of trend has taken place. The advantages of concentration have again been recognized, and the discarding of a large tonnage of waste and near waste is now being practiced before cyaniding is commenced—on so comparatively small an amount of material that the acme of refinement in technique may be introduced at small cost per ton milled.

Concentration and the cyaniding of the concentrate appealed to the pioneers as the logical method of applying the cyanide process, prior to the time when an inferiority complex developed in regard to the "immensity" of unit leaching charges of forty tons or so. When the potentialities of the process in its application to large unit tonnages was realized, the bolder sponsors of MacArthur's work abandoned concentration in many instances. Meanwhile, flotation has been applied with success to almost all types of gold ore, and so the basic advantages of cyaniding have become even more firmly established. The latest property to recognize and adopt this trend is the Kennedy, on the Mother Lode of California—a district where one may observe a reverence for technical tradition in the treatment of the ore, as well as indications of keen research in the development of processes inexpensively to recover the gold discarded with the residue from that ore.

Gold-Ore Mining and Milling

A California enterprise with an unusually simple metallurgical process—screen ball milling, Hungarian riffle tabling, Berdan pan amalgamation, in conjunction with stamp milling and plate amalgamation—insuring low operating costs and profitable operation

G. J. Young
Associate Editor

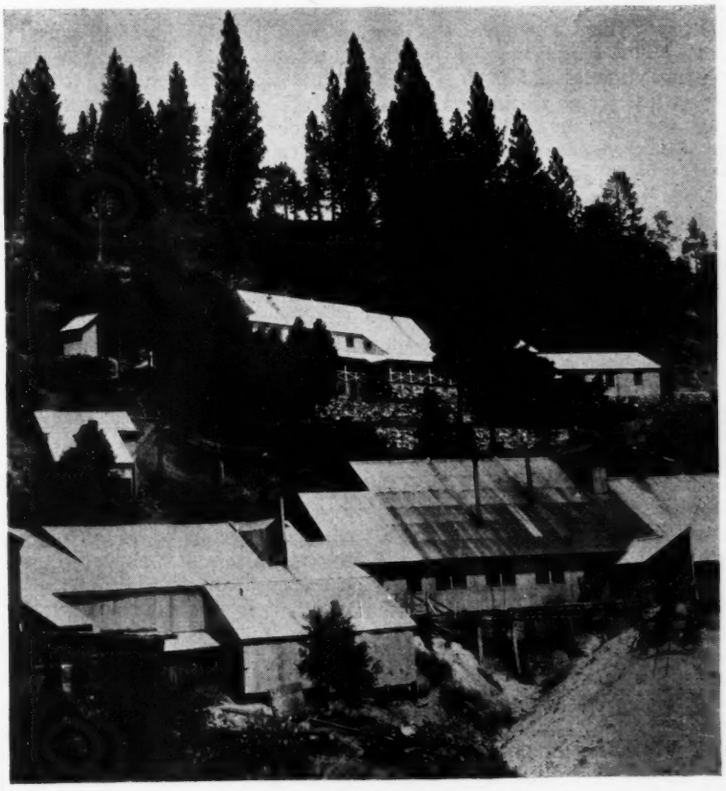
NEVADA CITY and Grass Valley districts, in Sierra County, Calif., have been important lode-gold producers for years. The newer Allegheny district, the most important lode-gold region nearest to the Nevada City and Grass Valley territory, is at an altitude of 4,000 ft., whereas the older districts are at an altitude of 2,500 ft. Granodiorite and diabases and some serpentine prevail in the Nevada City and Grass Valley area. The Alleghany district is in the carboniferous metamorphics, serpentine, and small areas of diorite and gabbro. The quartz veins have a marked similarity in both places. Henry G. Ferguson and Roger W. Gannett described the general geology of the Alleghany district and also discussed the habit of the quartz veins in *Technical Publication* 211 of the A.I.M.E. They estimate a probable total of over $20,000,000 lode-gold production for the district. The present article deals with the Sixteen-to-One mine.

Thomas Bradbury located the two fractional claims of the Sixteen-to-One in 1896, but the claims were unworked until Bradbury deeded a half interest to his brother Theodore. Y. C. Lawson joined with Theodore Bradbury in supplying the money for assessment work. The property was bonded to Wilson and Van de Bugle in 1907. What was then known as tunnel No. 2 was extended 50 or 60 ft. and a high-grade oreshoot was discovered, which yielded about $100,000. Some of the ore was hauled to Nevada City. Differences arose between Wilson and Van de Bugle, and the latter brought suit against the former. H. L. Johnson, of the Tightner mine, was appointed receiver. Under his administration the Sixteen-to-One winze was started and extended a short distance when the property reverted to the Bradburys and Lawson. It was next acquired by H. U. Maxfield and his associates, the Original Sixteen-to-One Mine, Inc., being incorporated Oct. 9, 1911.

Two neighboring properties enter the picture about this time. The Twenty-One Mining Company owned four claims and started work on a quartz vein, eventually drifting over to the Sixteen-to-One vein, where a rich oreshoot was discovered and ore worth about $100,000 was mined. Suit was begun by the Sixteen-to-One, and in October, 1919, it was awarded apex rights and $93,000. The four claims of the Twenty-One were purchased for $60,000 in 1920.

Tightner mine, the other neighbor, has an interesting history. The vein had been discovered in a bedrock tunnel of a placer property. It was not explored, but the old tunnel was reopened by H. L. Johnson, and a high-grade oreshoot was discovered. The Tightner property was sold in 1911 to a group of Grass Valley men headed by A. D. Foote. Payments, totaling $550,000, were completed in 1917. Production of the Tightner mine up to then is reported to have been about $2,000,000. The Alleghany Mining Company, incorporated in 1919, took over the property, completing its option in January, 1924, and soon thereafter it was sold to the Original Sixteen-to-One Mine, Inc. Fred Searls, Jr., was manager during the period prior to the sale of the property.

Litigation with the Twenty-One Mining Company is said to have made the Sixteen-to-One. Exploration work consequent on the litigation played a part



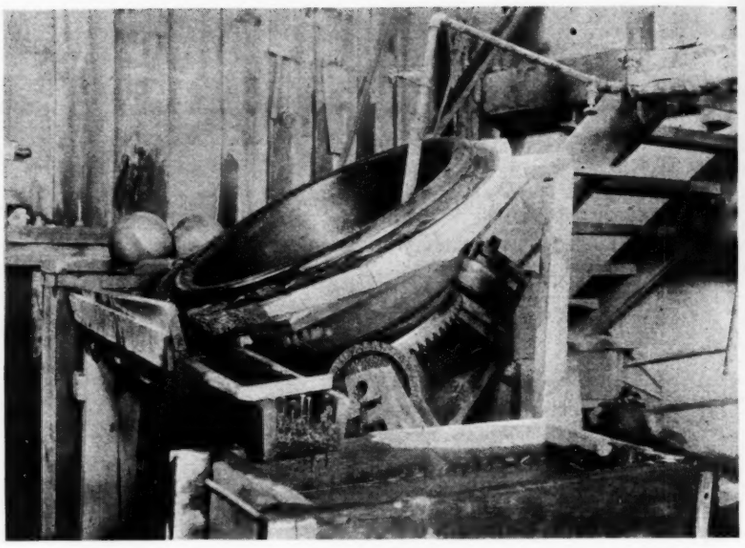
Surface buildings at adit

in showing the possibilities of the mine, and the knowledge of geological conditions was a factor in stimulating the Sixteen-to-One company to greater activity in exploring new ground. The yield for the period 1919-28, inclusive, was about $6,000,000, of which about 25 per cent was derived from milling operations.

The mine's surface plants are on a steep slope below Alleghany and north of Kanaka Creek. In this area the topography is such that both plants are extended out along a contour level, the Tightner adit being at a lower altitude than the adit of the Sixteen-to-One. The mine is served by two incline winzes, from which the levels are extended. The Sixteen-to-One winze, one compartment, 4½x5 ft., with a manway 3x5 ft., extends to the 1,300 level, with levels north and south of the 250, 300, 400, 500, 600, 800, 1,000, 1,100, and 1,300 stations. Its slope varies; to the 250 station it is 50 deg., but below this point it averages about 35 deg. The two-compartment Tightner winze is 4 ft. 4 in. by 5 ft., with a manway of the same dimensions. Its angle varies; to the 1,500 station, an average of 31 deg.; from 1,500 to 2,100, 45 deg. A pentice was left at the 2,100 station, and the winze continued to the 2,750, below which point it was continued as a single compartment and manway to the 3,000 level at an angle of 60 deg. The vertical depth served is about 2,000 ft. below the Tightner adit. The deepest point is 2,478 ft. altitude, or about the same as Grass Valley.

Measured on the dip, the distance covered by the workings is a little over 3,000 ft. from the apex under the lava capping. The length served by the drifts approximates 2,500 ft. Comparatively little cross cutting was done, although the Tightner adit is a crosscut. On the 2,100 level, as a result of a fault, a 200-ft. crosscut in the footwall of the winze was necessary to cut the vein. Thus the mine development workings are almost restricted to the plane of the Sixteen-to-One vein. The 800 level of the Tightner connects with a drainage adit.

The area of vein exposed by the development work is about 7,500,000 sq.ft. Below the Johnson upper tunnel and above the Tightner adit is a fault that intersects the vicinity of the 250 and 300 levels of the Sixteen-to-One. Its displacement varies from 30 ft. to an estimated maximum of 100 ft. The Tightner faults are steep, dipping 70 deg. to the west. Between the 250 and 1,800 levels only minor faults occur, parallel to the Tightner fault and with displacements from a few inches to as much as 15 ft. The lower main fault intersects the vein at the 1,800 level. Its displacement is about 180 ft., the eastern segment of the vein being displaced downward. The strike of the fault is apparently a little more northerly than the upper fault, although both fault planes appear to approach toward the south. In the lower main fault the strike is north 20 deg. west. The strike of the vein is north 15 deg. west, but varies considerably. The vein dips to the east.



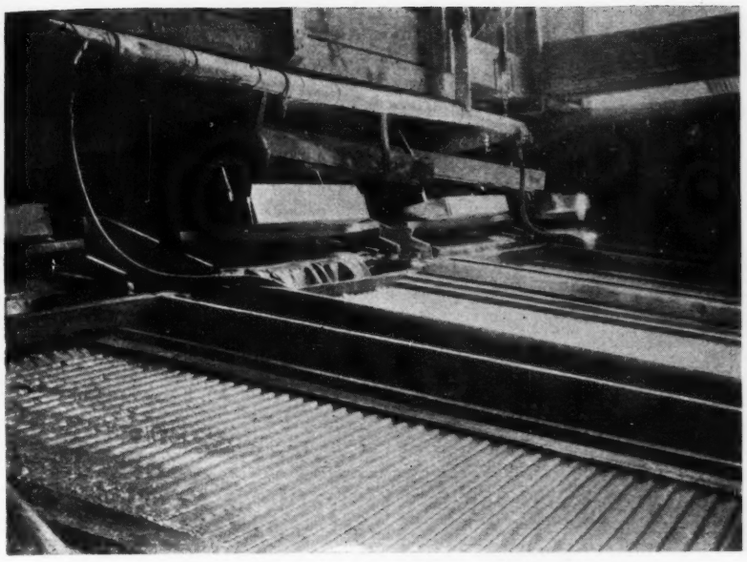
Berdan pan used in working riffle concentrate and sands

When the Tightner winze struck the fault plane in the vicinity of the 1,900 level, and the vein disappeared, the winze was continued. The present superintendent asked Maxfield how far sinking was to be continued before crosscutting. Maxfield said: "How long is the rope?" The superintendent replied, "Twenty-one hundred feet." Maxfield then said: "Sink to the end of the rope." The crosscut was started at the 2,100-ft. point, and at 200 ft. (in the footwall of the winze) it struck the upper tip of the segment of the vein This is probably the only known place where a hoisting rope solved a fault problem. Continuation of the winze at an angle of 60 deg. intersected the hanging wall of the vein at the 2,700-ft. point. From this point the winze followed under the vein at a 60-deg. slope to the 3,000 level.

Characteristic of both winzes is a considerable variation in the angle of slope, and characteristic of the drifts is the variation in the strike of the vein. The vein varies in width from a seam to a maximum of 30 ft. It is a vein to gladden the heart of a miner, for it is of white quartz, ribbon structured in places, massive in others. Its curvature, slips and faults, pinches and enlargements make it an enchanting miner's problem. However, when it comes to "values," the miner's problem becomes bewildering. Much of the quartz is too low-grade for profitable extraction. The sweetening in the vein, occurring at irregular intervals and varying in amount—the plums in the pudding—are the lure that drives the raises and their fingers into the nearly barren quartz, and the gold from them keeps the mine on a paying basis.

The Sixteen-to-One is not a pocket mine. Its oreshoots are unlike those in the Grass Valley mines, unlike the South African reefs, unlike the Hollinger veins. The gold is not at all uniformly distributed in the quartz. The quartz can be followed, but the vein enrichments vary in size, in distribution, and in total amount of gold gained therefrom. Often they are close to the hanging wall, in some instances near the footwall, sometimes in the pinched portions, more often in the enlargements. Usually commercial mineralization occurs near a system of slips, and it is more often in the gently dipping areas than in the steeper parts of the vein. Geologists and practical miners have sought some system whereby the enrichments could be more cheaply found than by the driving of a series of raises into the blank vein and fingering these out when negative results are obtained. So far, the most successful postulate appears to be that the enrichments are in the vicinity of the serpentine intrusions that intersect and are faulted by the vein. But even this may be disproved by future working.

Another disconcerting feature is the fact that a working may be within a few inches of an enrichment, and unless the telltale of a sparkle of gold is detected the enrichment will be passed by. Needless to say, the quartz exposed by each round in the drifts and raises is minutely examined. Cut samples and assays are of little value. All the quartz mined and secured from development workings is sent to one of the mills. Some gold is thus obtained—one or two dollars to the ton—except where the quartz is from the vicinity of an enrichment. Drifts are driven wide and high, 6 to 7 ft. by 7½ ft. or more; raises are 7x12 ft., or larger. Surface exposure in such workings is the objective. Drillings are panned, and sometimes afford a clew to an enrichment.



Riffled stationary tables below narrow sluice

Below the 250 level and above the 800 drain tunnel, north of the Sixteen-to-One winze and south of the Tightner compromise line, has been the richest portion of the Sixteen-to-One mine so far. The Tightner workings were extremely rich for several hundred feet further north. The block in the Sixteen-to-One containing 400,000 tons has been extensively stoped. The average of the production has been about $24 per ton, which includes the enriched ore, about two-thirds being derived from enrichments and the remainder from milling.

Mining differs from that ordinarily practiced in that the development merely exposes quartz runs, which must be explored by cutting. This is done by 7x12-ft. raises. The broken rock is handled by scrapers. As the slope distance for this operation is limited to 200 ft., the approximate level interval is thus established. However, levels were driven closer than this in the upper part of the mine, principally for exploration. Minimum cost is reached in the raises. At present 100 tons per day is being mined from drifts, stopes, and raises; in addition, 40 tons per day is being stoped from an area containing gold more finely divided than that ordinarily found in the enrichments. The former is sent to the Sixteen-to-One mill; the latter to the ten-stamp Tightner mill.

The Sixteen-to-One winze is equipped with a single-drum, double-reduction geared Taylor hoist driven by a 75-hp. motor; the Tightner hoist is double drum, 100-hp. motor, 2-ton skip. The winze below the 2,100 level is served by a single drum, Denver Engineering hoist, operated by a 50-hp. motor handling a 1-ton load. Manganese-steel shaft rollers are used, and winze tracks are 40-in. gage. A special car is used for handling men.

Above the 1,300 level the mine is ventilated naturally, but on the 900 level a 12-in. Root blower belted to a 15-hp. motor supplies a 12-in. ventilating pipe to the 3,000 level. Ten-inch branches equipped with gates take off at the various levels below the 1,300. On the 2,400 and 3,000 levels auxiliary fans, Coppus blowers driven by compressed air, are arranged for suction or for blowing. On other levels Coppus blowers are also installed. At the 1,500 level, a Sturtevant fan driven by a 10-hp. motor supplies auxiliary ventilation. The network of workings makes ventilation a subordinate problem.

The Tightner winze is the main drainage outlet. A 4-in. column serves the mine below the 2,100 level and a 6-in. column from the 2,100 to the 800 level (drainage adit). At the 3,000 is a Byron Jackson two-stage centrifugal (25-hp. motor), handling 170 g.p.m. against a 250-ft. head. A dammed-up drift and a sump furnish storage at this level. A compressed-air operated sinker drains the winze sump. On the 2,700 level, two four-stage Byron Jackson centrifugals (25-hp. motors), each 100 g.p.m., operate against a 500-ft. head. One or both are used as necessity dictates. Sump storage on the 2,100 level is provided by the crosscut, from which the water is removed at intervals by a Worthington triplex pump (double unit driven by a 40-hp. motor), 150 g.p.m., 720-ft. head, discharging at the drainage adit. A 150-gal. belt-driven horizontal Taylor pump (25-hp. motor) is used for emergency service and pumps to the 1,300 level, where a 300-gal. Taylor pump (50-hp. motor) of the same type relays the water to the drainage adit against a 250-ft. head.

Motors for the centrifugal pumps are direct-connected; motors and bases are interchangeable. A spare motor is carried in storage. Electrical power is provided at the Tightner adit by an armored cable, 6,600 volts, to three 100-kw. marine-type transformers near the hoist. A lead-sheathed, three-wire conductor, encased in a wooden box placed in the manway, supplies 440-volt current to the stations down to the 2,100 level. From this point to the 3,000 level, a smaller armored cable serves the winze. Water is generally present in the mine, but the flows are relatively small and only occasionally is the opening up of new ground accompanied by more than the normal amount of water.

Two Imperial-type short-belt compressors supply the principal requirements of the mine. At the Tightner adit another belt-driven compressor is available, used in emergencies. A 4-in. pipe line serves the Sixteen-to-One winze to the 800 level and connects by a 4-in. pipe with a 6-in. pipe line leading from the Tightner compressor. Below the 800 level 4-in. pipe lines are used in the winzes and are interconnected by 2-in. pipes on the 1,000, 1,100, and 1,300 levels. The 1,500 level is served from both ends. Two-inch air pipes are used on levels. The interconnected system gives receiver capacity. The 90-lb. pressure at the compressors yields 75 lb. or better at the working faces. Merco-Nordstrom and Knox valves are used on the air lines. Drilling water is piped from near-by sources in the mine. Drinking water is supplied by a 1-in. line to the 800 level; below that point by a ½-in. line, Foster pressure valves being used to control pressures.

No stopers are used in the mine. All drills are 3- and 3½-in. column-mounted wet drills, IRL 74, N 75, and Gardner-Denver 7. A Worthington-Gilman, Model 25, is being tried out. No line oilers are used except on the Gardner-Denvers, but each driller is supplied with a steel oiling flask. Air hose is 1 in. All drilling machines are fitted to take a standard 1¼-in. Leyner shank. Round steel (1¼ in.) is generally used, with some 1-in. quarter-octagon with 1¼-in. shanks. Hand-held drills are not used but are available.

Double-drum scraper hoists operate throughout the mine. Equipment consists of four No. 300 Waugh hoists; two No. 311; two IR 6H; two IR 6HC; and one Sullivan electric, H.D.E. 7. In addition, six Tugger single-drum hoists are in general use in the mine and in the surface plant. Scrapers weigh about 250 lb., and are 34 in. wide, to fit the skip. The scraper is without teeth, non-reversible, and equipped with a replaceable plow-steel blade. Ordinary 6-in. snatch blocks with cast-steel sheaves are used with ⅜-in. steel cable. Side plates are attached to the sheaves. Raises are wing-boarded at the loading points, and a chute gate is used for a control, the scraper hoist being mounted on the opposite side of the drift.

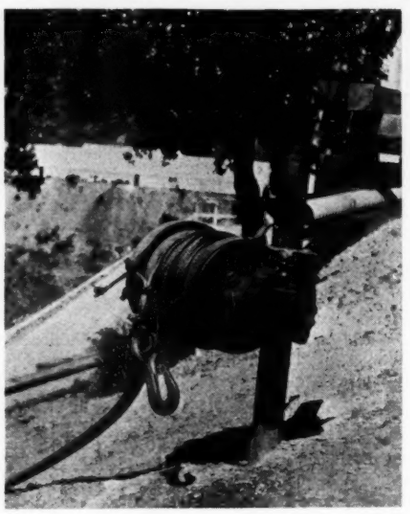
Drift rounds are 3½ ft. long, 5-ft. cut holes, and 14 to 16 holes per round, requiring 75 to 86 sticks of 40 per cent Hercules dynamite. No. 8 blasting caps

are used. Heavier drills, with 1¼-in. round steel, are used in drifting. The lighter drills are used with quarter octagon steel in the stopes. Wide raises require 24 holes; two shifts of drilling are necessary to put the face ahead a round. Sometimes half the raise face is blasted; at other times half the face is drilled, after which the drill is moved over, and the next shift finishes the drilling and blasts the face. The quartz is hard, and good steel is necessary. Five drills are in operation per shift. Drifts are advanced a total of about 15 ft. per day. Stopes are timbered with stulls set in hitches in the footwall, but most of the drifts are untimbered, as the ground stands well. Explosives average about 350 lb. per day. The principal work is restricted to two shifts per day, one being used for drilling and blasting and the other for mucking out development faces. Shop equipment consists of a lathe and accessory tools. An Oxyweld portable acetylene generator and welding equipment is provided. The drill sharpening shop is equipped with two IR sharpeners and an oil-fired forge. A timber framing shed, storage houses, and magazine are included. Change rooms are provided with furnace heat and hot and cold showers. The company has ten dwellings that are rented to employees. A competent doctor is maintained by the company and its employees.

Milling arrangements formerly consisted of a twenty-stamp mill, plate amalgamation, and Wilfley tables at the Tightner adit, and a ten-stamp mill at the Sixteen-to-One. Present arrangements include a modern, cast-iron frame, ten-stamp unit at the Tightner, equipped for plate amalgamation and followed by a Wilfley concentrator. This is used for milling at the rate of 40 tons per day. Practice follows established custom.

Sixteen-to-One's mill indicates a radical departure from accepted gold-milling practice. The ore is crushed by a 10x16-in. Hercules breaker driven by a 20-hp. motor. It is delivered from the crusher bin by a Challenge feeder, operated by a cam and roller, to a feed belt discharging into the scoop hopper of a 5x4 Hendy ball mill equipped with a manganese-steel grid. Five-inch forged chrome steel balls are used for grinding. The scoop feed, lined with manganese steel, is provided with a manganese-steel lip. The thick discharge is received by a cylindrical trunnion screen, in which a coil of ¾-in. wire rope conveys the oversize to a spout discharging into the boot of a small bucket elevator, which returns it to the feed hopper of the ball mill.

In the existing flowsheet, the outlet or scalper screen is a Tyler steel unit with the long side of the rectangular opening in the direction of rotation. The width of opening is 0.29 in. Screen undersize is laundered to a steep sluice 12 in. wide by 10 ft. long, equipped with Hungarian riffles of manganese steel, discharging into a Dorr simplex classifier 2 ft. 3 in. by 14 ft. 8 in. (slope 3¾ in. to 1 ft., 30 strokes per minute). Classifier content is maintained at a high density, almost the same as the discharge of the ball mill. Overflow is diluted and sent to a bank of riffled



Apparatus used for hoisting rich sand

tables below, and the rake discharge is spouted to the elevator boot. A 75-hp. motor drives the ball mill, elevator, classifier, and feeder belt, and for this purpose takes about 60 hp., the feed rate being 100 tons per day.

The diluted pulp is divided among four 3x8-ft. stationary tables, each with ⅜-in. riffles spaced ¾ in. apart and placed over canvas. Discharge from the four tables is passed over three 5x12-ft. riffled tables in series. Riffles are ¾ in. spaced 1½ in. apart and are on canvas. All of the riffled tables are set on a grade of 2¾ in. to 1 ft. Traps of the mercury type are also used. The final tailing passes through an automatic sampler.

All of the riffled tables are provided with side strips (2x3 in.), which are lifted up and the riffles cleaned by sweeping the concentrate to either side and brushing it down into a tray, a little water being used. The first bank of tables is cleaned up once in 24 hours and the second series at from two weeks' to a month's interval. No amalgamation is attempted, but the product of the riffles is cleaned up by amalgamation in a Berdan pan, the residual sand and accompanying concentrate being settled and then removed for shipment to the smelter. Berdan-pan tailing averages about $80 per ton.

A screen test on the classifier overflow gave the following result: On 20, 15½ per cent; through 20 and on 40, 24½; through 40 and on 60, 11; through 60 and on 100, 15½; and through a 100 screen, 33½ per cent. Corresponding tailing was as follows: on 20, 16½; past 20 on 40, 24; past 40 on 60, 13; past 60 on 100, 15; past 100 screen, 31½ per cent. Average assays of the plus-40 mesh are very low and of the minus-100 are higher than any other of the screen products.

The classifier sluice removes the coarse gold, amounting to about 70 per cent of all the gold, but catches much less of the final metal. The first set of four tables catches about 12 per cent of the gold and the three in series from 7 to 8 per cent. Tailing averages 40c. per ton in gold as a minimum, and increases with an increase in the grade of the ore, but not in proportion, as the extraction rises with the ore grade. Heads of $5 per ton give an extraction of 90 per cent. Some examples follow:

Recovery of Gold Per Ton	Extraction, Per Cent
$1.60	69.2
1.77	79.5
2.62	84.0
3.21	86.0
3.77	86.2
4.12	88.2
5.02	87.7
5.75	90.5
6.97	87.9
9.55	91.7

The significant features of the milling practice are its simplicity, its effectiveness, and the small force required for its operation. Power requirements are also low. The wide variation in the assay value of the feed precludes intensive efforts to reduce the gold content of the tailing to a minimum.

Amalgamating plates were used at one time, and the transition to riffled tables was gradual. Corduroy and matting were tried, as was also a narrow pilot plate before the riffles, but this was successful only when the feed was exceptionally high.

The ore is highly abrasive. Ball consumption is 1¾ lb. per ton; side liners last six months; throat liners, three months; head liners, four to five months; white-iron lifter bars, two to three years; and manganese-steel screens, six months.

Tightner's mill is equipped with 1,250-lb. stamps, each five-stamp battery being driven by a 20-hp. back-geared motor and long belt. A needle-punched screen of approximately 30 mesh is used. A lip plate and an outside amalgamating plate, 5x6 ft., terminates in a 3x6 riffled table, the pulp passing a mercury trap and being treated on a Wilfley table. Concentrate averages $80 per ton. The capacity is about 40 tons per day. Ore containing gold in finely disseminated condition, as it is in one part of the mine, gives more satisfactory results by battery amalgamation. A Berdan pan is used for clean-up.

Both mills are practically operated as "guards" upon the mine and serve to prevent the loss of particles of coarse and fine gold that may be sporadically distributed in the near barren quartz. Enriched ore is hand sorted out at the faces in stopes, drifts, and raises, when

it is encountered, and taken to one of the clean-up rooms, where it is crushed by a small rock breaker and rolls and amalgamated in two Berdan pans. The residue sand is settled, dried, and shipped to the smelter. This material averages $300 per ton, but only a small amount is produced. Berdan pans are used with manganese-steel balls filled with lead and weighing 125 lb. each. All are of the under-driven type, and a false inset pan, renewable, takes up the principal wear. No amalgam is squeezed; it is retorted and the gold shipped.

Ninety men are employed. Power varies from 150,000 to 175,000 kw.-hr. per month, and is purchased.

Mine operators sometimes have to face unusual problems, and the methods that result are often the product of careful adjustments designed to strike an economic balance. Here, the erratic distribution of gold in the mine evolved a mining method designed to find the enrichments with a minimum extraction of the low-grade quartz. As might be expected, some months are without profit and even a whole year might be "in the red." A reserve of operating capital is thus necessary to tide over the lean periods. This has been provided by the company.

A. M. Smart was the first superintendent of the property. H. J. Langdon succeeded him, and was in turn succeeded by M. C. Sullivan. Theodore Bradbury, then Thos. J. Bradbury, with W. H. Goldsworthy as assistant, followed. The present superintendent is Clayton A. Bennett. Goldsworthy and Bennett, Nevada graduates, both made important improvements. The ten-stamp mill was erected in Sullivan's time, before which the low-grade quartz was placed on the mine dump. Also during Sullivan's superintendency a new compressor, snow sheds, new dwellings, and other important improvements were made. A rod mill was erected in 1923 together with the present ball mill. For the time being the rod mill is not used. H. U. Maxfield, the president, has directed the major moves of the company and its policies. A considerable degree of the success of the company is attributable to his executive and operating ability.

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Sharpening Thread Cutters

CORRECTLY ground and set thread cutters are essential in order to produce clean-cut pipe or bolt threads, and to avoid waste of time and material, writes Charles Labbe, Death Valley Junction, Calif. When threading small objects, the proper cutter contact point is a matter of importance. Fig. 1 shows a standard die holder and the incorrect cutting point of the four dies, which, in this case, owing to the small diameter of the bolt, is some distance from the center line at the tangent of the circle. This distance is not constant, but varies with the diameter. The point of contact of a die $\frac{3}{8}$ in. thick, threading a $\frac{1}{2}$-in. bolt, for instance, is about $\frac{1}{16}$ in. out of the center line; whereas on an 8-in. pipe it is but 1/42 in. Cutters used for threading small bolts or pipes should therefore be so adjusted that the cutting point of the die lies precisely on the center line of the object threaded. Another factor to consider is the cutting angle of the thread cutter. Dies with a cutting angle of 90 deg., as shown in Fig. 2, often cause trouble. On account of the flat angle, the threads are not cut, but pressed in, resulting in uneven and stripped threads. To avoid this the cutting angle should not exceed 74 deg. By allowing an angle of 15 deg. between the center line and the cutting point of the die, as shown in Fig. 3, clean threads, at less cutting pressure, are assured. Sharpening of the thread cutters can be done by hand, using a fine-grained emery wheel or a horizontal grinder, taking care that the thickness of the cutting part of the die is parallel and the size of the back part of the cutter exceeds that of the front part, for otherwise a side cutting of the newly formed threads may result.

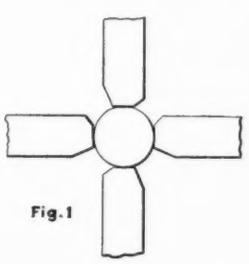

Fig. 1

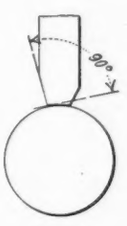

Fig. 2

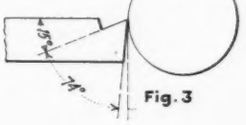

Fig. 3

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Ventilation Shaft Construction

TO AVOID sinking through ground which will be affected by caving operations, the No. 6 shaft at Miami Copper's property at Miami, Ariz., was sunk on a pitch of 30 deg., which made possible the use of drifting methods. Drilling was done with drifters, mounted on columns; mucking by a scraper and slide, the scraper being pulled by a double-drum hoist geared to a 10-hp. motor. Track is 45-lb. rail laid on a 42-in. gage. Three pieces of equipment—the slide, tool car, and skip—were hoisted or lowered separately and had to be removed from the track when not in use. A short section of the headframe, with the track over it, was cut out and mounted on a truck, which ran on a track at right angles to the line of the shaft, so that the removed section could be easily set back into the gap in the headframe. Two more removable sections, similar to the first, were made, and two pieces of equipment could then be clamped to these removable sections and moved away while the third section and the third piece of equipment were being used. The shaft is timbered with fir drift sets treated with zinc chloride, consisting of 10-in.x 10-in.x9-ft. 2-in. caps and 10-in.x10-in.x 8-ft. posts battered 2 in. per foot. Sets were spaced 6 ft. 3 in. apart, center to center, except in a few places where the ground was heavy, where a 3-ft.1½-in. interval was necessary. The shaft will be lined with treated 1-in. boards, which will be given a coat of Gunite for protection against fire.

At the top of the shaft a No. 12 single-width, single-inlet, high-speed fan will be installed, driven by a 100-hp. motor. It is expected to exhaust 80,000 cu.ft. of vitiated air per minute from the mine workings. The only upcast shaft at present is No. 4, through which 151,000 cu.ft. of air per minute is exhausted. No. 3, a ventilating shaft, equipped with a fan at its collar, downcasts 84,000 cu.ft. of air per minute. No. 5, the main working shaft, downcasts 46,000 cu.ft. per minute without fan equipment.

Diamond Mining In Borneo

Sidney H. Ball

FOR SEVERAL CENTURIES Borneo has produced alluvial diamonds. Until diamonds were found in Brazil, in the third decade of the eighteenth century, the production there was exceeded only by that of India. Certain features of the deposits, their history, and the method of mining appear to warrant this compilation. At present the annual production of Borneo is only 1,000 or 2,000 carats (equivalent to a few hours' output of the Union of South Africa's mines), but at the peak of production, late in the eighteenth century, the Dutch imported stones to the value of £90,000 ("Dutch Borneo"—handbook of British Foreign Office), suggesting a total annual production of 50,000 carats or more. In the 'thirties of the last century production probably approached 10,000 carats (about 5,000 carats were then exported to Java).

Some years ago (*E.&M.J.*, May 29, 1920) I estimated the total production of Borneo as about 1,000,000 carats; or, say, 1/14th that of Brazil and 1/12th that of India. This probably is an underestimate rather than an overestimate. The large production of the Brazilian fields in the eighteenth century hurt the industry, the mines even then probably approaching old age, and production was still further pinched in by the growth of the African diamond industry.

• • • In Borneo, diamonds occur as a constituent of modern river gravels and of terrace gravels of Quaternary age. The satellites of the southern deposits at least (Martapura) suggest that the gems are derived from basic igneous rocks; and although such rocks occur in the hills from which the gravel is derived, the original source is unknown. The diamondiferous deposits are normal in that they consist of a layer of barren overburden with the pay-streak between it and a clay hardpan below. Normally, the well-rounded diamondiferous gravel is from ½ to 8 ft. thick. The ratio of thickness of overburden to that of pay gravel is high. Two principal diamondiferous areas exist, one in the southwestern quarter of the island, where scattered deposits have been found over an area of about 20,000 square miles, and a second in the extreme southeast part of the island, of an area of about 10,000 square miles. Landak and Martapura are the more important producing centers of these areas, the latter being now the larger producer.

The number of miners employed at the diamond mines is about 1,000. The aborigines undoubtedly always furnished the major portion of the labor. The Chinese, probably largely as master miners and adventurers, early entered the field. Purchas ("His Pilgrimes," Vol. 1, p. 233, 293; 1625) infers that in his time they were the chief producers. From 1842 onward their position was less important, for in that year the Chinese master miners were massacred by their Dyaks employees. A still lesser element among the miners is the Malay.

• • • Methods of mining are primitive and do not differ much from those of gem mining in Ceylon. (See notably A. S. Wheler and J. H. Foran, *Min. Mag.*, July, 1923, pp. 9-13; and T. S. Raffles, "History of Java," 1830, Vol. 1, p. 265-7.) A family or a group of natives work the claims, for which a small license is paid, or a richer native finances the operation, with the proviso that all stones found be sold him at a fixed price. The petty local sovereigns claim the right to purchase all stones of five carats or over, at a price satisfactory to them. Scarcely remarkable is the fact that the miners smuggled such stones out of the district.

A small shaft is sunk through the diamond-bearing gravel, lagging being used when necessary. Proof that the pay has been reached is the presence of certain satellites of the diamond, which are used as indicators—corundum and brookite in certain districts. Water is removed with a Standard Oil tin, a type of heavy machinery of recent introduction. Shafts may be 60 ft. deep, but they rarely exceed 30 ft. The gravel bed is undermined as far as the natives dare, and fatal cave-ins are relatively frequent. The "pay" is handed up in wicker trays, to men stationed at as many "levels" in the shaft as is necessary. If clayey, the gravel is puddled with the mill-man's feet in a hollow log, then sometimes roughly sized in a rattan sieve, washed in a batea, and the diamonds are hand picked out of this material. Gold and platinum are by-products in some of the deposits. Wheler and Foran (*op. cit.* p. 12) state that when stones are found in the Martapura field the panner "imbeds them in a small wax-filled hole bored in the rim of the batea." John Crauford (Journal Royal Geographical Society, London, 1853, Vol. 23, pp. 73-4) states that the Chinese rarely prospect, but reopen mines abandoned by Dyaks and Malays if favorably situated to permit sluicing off the overburden. Washing is done in a wooden trough at a stream of water.

Average return is pitifully small. As in most alluvial diamond digging, the incentive is the hope of finding an unusually fine stone. Raffles (*op. cit.*) suggests that the Chinese make about 20 to 24 rupees a year ($4 to $5). Beccari ("Wanderings in the Great Forests of Borneo," p. 121-2), who traveled in Sarawak from 1865 to 1868, mentions one Malay diamond washer who had in three months made only about $5; another, less than a dollar a month. Others of course must do much better, but the figures suggest why European attempts in the past century at mining by modern methods have failed.

• • • The average quality of the stones is good, the luster being remarkably adamantine. Bornean stones sell in the Indian Archipelago at a higher price than South African stones, and in the seventeenth century Tavernier says they were preferred in India to Indian stones. Perhaps they are scarcely as good as the Brazilian. Poor parcels that reach Europe from time to time undoubtedly account for the unsavory reputation given them by certain authorities.

The small size of the stones is emphasized by most writers, but Wheler and Foran (*op. cit.* p. 12) state that "the stones probably do not exceed ¼ carat on the average." If the figure is correct for the Martapura production, the average size is at least as great as that of most producing fields. Likewise, the contract made by the Dutch in 1823, later described, also suggests that fair-sized stones must have been quite common. Compared with India and South Africa the district is not one of large stones, but considering its relatively small production large stones are more common than in the other fields of the world. Among its notably large stones is the Star of Sarawak, found by a Chinaman at Landak about 1877. He sold it to the English Rajah of Sarawak, and early in the 'eighties it was on exhibition in London. Its uncut weight by one authority is given as 87 carats and the cut at 70. The Rajah of Landak is said to own the "Segima," of 70 carats, and another stone of 54 carats, and two other stones of about 70 carats are reported to be in the possession of other Bornean potentates. I know of six or eight other Bornean stones above 20 carats.

The shape of the stones is rather good, the octahedron predominating with fewer dodecahedra and other less simple crystal forms. Some crystals appear slightly water-worn, but some of the octahedra are so perfect that the natives wear them uncut. Colorless and slightly yellow-tinted stones predominate, which in the "History of Jewels" (London, A.D. 1671) is explained as due to the fact "that they are found at the bottom of a river amongst sand which is pure and has no mixture or tincture of other earth, as in other places." Deeply colored stones are more common than in most fields: reds, blues, smoky stones, and black occurring. An unusually fine red diamond from Borneo was sold in Paris early in this century. The black diamond is of magnificent luster and beauty and is much in demand for mourning jewelry in the East. The Bornean diamond is, like the Australian, harder than stones from other localities.

• • • A local diamond-cutting industry center has been established at Martapura, and formerly there was one at Pontianak. The proprietors are Arabs and to a less extent natives, and the labor is native. Wages are low and the work is poor, but it is satisfying to the Eastern trade. Formerly only Bornean stones were cut, but South African and a few Australian stones are now imported. The South African stones are bought in Amsterdam and in certain years as many as 100,000 carats of imported stones (usually off-color) are cut. From the beginning of the World War to date the leaders in the industry have had a hectic time, owing first to a restricted supply of rough and then to a poor market for the cut product in the East. At times as many as 1,100 artisans are employed. J. H. Curle ("This World of Ours," 1921) describes a single factory with 400 artisans who work with modern diamond-cutting equipment. The local artists cut for size and effect, and in consequence from the European viewpoint the cutting is crude. John Crauford ("History of the Indian Archipelago," Vol. 3, p. 491-94, Edinburgh, 1820) describes the industry in his day, over a century ago, and is probably right in believing it a relatively old industry in Bornea, as the names for both uncut and cut stones (respectively "pudi" and "intan") are native names.

Diamond merchants in Borneo are largely Arab, although both Dutch and Chinese have also tried their hand at it. A certain number of stones have been exported to China since at least early in the sixteenth century. De Morga in 1598 ("The Philippine Islands—at the Close of the Sixteenth Century," Hakluyt Soc. 1868, p. 342) states that the Portuguese of Malacca were then trading in Bornean diamonds and sixteen years later the Dutch were competing with them (Joris van Speilbergen: "The East and West Indian Mirror," Hakluyt Soc. 1906, p. 158). In the seventeenth, eighteenth, and nineteenth centuries, the major portion of the exports went to Batavia from Pontianak and the prosperity of the industry fluctuated with that of the Dutch colonial metropolis. Stones are now shipped to Java, Singapore, Siam, Shanghai, and other eastern points. Pontianak and Benjermasin are the chief shipping points, and it was largely to control the diamond trade that the Dutch established trading posts at Landak and Sukadana in 1608 and the British at Banjermasin in 1698. From time to time parcels of rough diamonds were sent to Amsterdam, particularly in the seventeenth, eighteenth, and first half of the nineteenth centuries, and some to England when she controlled Java 100 years ago.

The diamond fields of Borneo have been exploited for a long time, but of their early history existing knowledge is most imperfect. Of the fields, Landak in the western part of the island, was first exploited. The Sangau field, near by, has been known a shorter time. The Martapura field is said to have been discovered late in the seventeenth century, and the Kosean as late as 1820 (T. S. Raffles: "History of Java," 1830, Vol. 1, p. 265).

• • • European travelers in the sixteenth found a well-established diamond-producing industry in Borneo, which doubtless had already existed a considerable time—probably several centuries. Most historians date the discoveries from the arrival in Borneo of the Malays 700 to 1,000 years ago. I am not impressed with the logic of this conclusion, for so far as I know the Malays at that time were not familiar with diamond mining. About 600 A.D., however, the southeast part of the island not far distant from the known diamondiferous area was a center of Hindoo culture. At that time the Hindoos had for well over a thousand years been diamond miners, and it seems reasonable to suppose that some Hindoo either found the first diamond or identified a stone in the possession of an aborigine, perhaps a medicine man, for such at present rank the much less brilliant rock crystal among their most powerful charms. The sacrificial ceremony when a mine is opened up, described later, suggests an Indian origin for the mining, for in India, on opening up a diamond mine, cattle are sacrificed (V. Ball Tavernier's Travels, Vol. 2, p. 358). The Hindoos were later driven out of Borneo, and in consequence we may guess, and admittedly it is merely a guess, that diamonds were discovered in Borneo between the sixth and tenth centuries of our era.

The earliest European who realized that diamonds in the East were not restricted to India was Duarte Barbosa, who spent from about 1500 to 1517 in the Indian service of the Portuguese and completed his account of his travels in 1518. He refers to an uninhabited island off the Coast of Cochin-China "the name whereof I know not, where many diamonds are found which the people gather and sell to foreigners, but they are not so hard as those of Narsyngua" (India), ("The Book of Duarte Barbosa," Hakluyt Soc. 1921, Vol. 2, p. 210). The reference is evidently to Borneo itself or to some island near by where Bornean stones were traded in. Barbosa probably here repeats gossip he got from some Oriental pilot, as the first Europeans to visit Borneo were Magellan's men in 1522.

• • • In 1540, Feran Mendez Pinto, in his "Observations of China, Tartary, etc." (Purchas, "His Pilgrimes, Vol. 12, p. 62), refers to "the diamonds of Laue and of Taniampura in the Isle of Java." Lavi River is a well-known district in Borneo, and doubtless the reference is to Borneo, for in the Middle Ages Borneo is often referred to as Greater Java. Garcias ab Horto, physician to the Viceroy at Goa about 1565, says "there is another rock on the sea of Tanjan in the Malacca country which yields diamonds, also called 'Diamonds of the Old Rock,' of small size but fine quality. One fault they have they are very heavy which makes them more liked by the sellers than the buyers." V. Ball ("Tavernier's Travels," Vol. 2, p. 359) believes that in this passage Malacca should be Borneo and Tanjan, Tandjongpura. Some support is given this view as Linschoten (who traveled in the East from 1583-94—Hakluyt Soc., 1885, Vol. 2, p. 137-8) repeats the statement as to the great specific gravity of the Bornean diamonds. The latter traveler gives in some detail an account of the diamonds occurring "in the straight called Taniapura" (evidently Tandjongpura) on the west coast of Borneo. Pedro Teixeira (Hakluyt Soc., 1902, p. 232), a Portuguese physician who spent from 1586 to 1601 in India and returned there in 1603, describes the mining methods in the kingdom of Laue in Borneo. Capt. Henry Middleton (1604) and Capt. John Saris (1609) are the first Englishmen to describe the mines, although Ralph Fitch (1583-91) probably refers to Borneo in his Laban and Tamba islands "among the Javas" which produce diamonds. Jean Baptiste Tavernier, in his famous book descriptive of his travels in the East from 1631 to 1689, stresses the quality of the Bornean diamonds, the high price at which they sell, and refutes the belief then prevalent that the stones were softer than those of India. He did not visit the mines, as "The Queen of the Island does not allow foreigners to carry away the stones and there are great difficulties in conveying them thence. The insignificant number, which are carried away secretly are sold at Batavia" (Vol. 2, p. 88). All of the seventeenth century accounts are of the mines near Sukadana and Pontianak. The earliest European references indi-

cate that, like so many other gem fields in the Middle Ages, the Bornean diamond fields were royal monopolies. Governmental meddling with mining continued a long time, for when the famous Matan "diamond" (probably rock crystal) was found about 1789 by a Dyak, it was claimed as a royal prerogative by the Sultan of Matan, Gúrn-Laya.

About 1794 the Dutch abandoned their trading post at Pontianak, but they reestablished it in 1823 (George Windsor Earl: "The Eastern Seas or Voyages and Adventures in the Indian Archipelago in 1832-33," p. 243-5. Also Royal Asiatic Soc. Jr., Vol. 4, 1837, p. 174-86, and "A History of the Indian Empire," by Ritchie, 1848, Vol. 2, p. 104-5). At this time they purchased the diamond mines from the Sultan of Sukadana for $50,000, stones below four carats to be the miner's property and those of larger size to be sold to the Dutch at 80 per cent of market price. The first two years of operating showed a profit of only $7,500, and thereafter even less, probably in part because the natives did not work hard on company account and in part because the better stones were secreted. Industrious Chinese, however, appeared to be making good money in near-by mines. The solution appeared to be simple. The Dutch sent troops, drove the non-resisting Chinese off, but in turn were forced to abandon the mines when they found the wells poisoned. Then the Dutch blockaded the coast with gunboats, and, not being able to dispose of their product, the Chinese finally made peace, promising to trade through the Dutch ports. Actually they decided to live without imported articles, and to save the gems till they had made a stake, when they left Borneo for China. This "war" however did keep Chinese from emigrating to the island. The Chinese at Landak had, of course, been working for a long time, but in 1842 their Dyak employees, whom the Chinese had treated with atrocious cruelty, either massacred them or drove them out of the mining district.

Some of the superstitions of the native miners are amusing. When a miner has selected his claim he calls in a "Malim," or medicine man, who examines the property, and who holds that in some way he can detect the glitter of the diamonds in case they are present on the claim. If his examination is satisfactory a white animal, either a buffalo, goat, or rooster, is slaughtered. The roasted meat of the sacrificial animal is then left on a frame on the claim for an hour to permit the spirits to feast on the smell and thus be induced to give up the diamond which they guard. Those natives present then eat the meat. For from three to seven days the miners intentionally do not visit the claim, but after this period mining begins. If results are unsatisfactory the "Malim" returns, and soon decides that the spirits are not satisfied with the extent of the sacrifice. He then hangs on a tree close to the shaft an egg and four balls of cooked rice of different colors. Burnt offerings are made, and the next day the ground is sprinkled with water in which the rice and a rough diamond has been cooked. If after these heroic methods, mining is not successful the "Malim" naturally concludes that the spirits do not consider the time ripe to commence mining and in consequence the only thing to do is to wait a more propitious time. Similar ceremonies occur if the gravel falls off in grade or approaches exhaustion.

The practices described in the foregoing are old, and Captain Daniel Beeckman ("A Voyage to and From the Island of Borneo," 1718, Pinkerton's "Voyages," Vol. 11, p. 124) was told by the natives that they held out for such high prices for their diamonds and gold because "the devil (I suspect the captain was a Puritan), who is the sole master of all the gold and diamonds that lay hid in the earth, often appeared to them in the mines, striking some of them dead on the spot, afflicting others with sickness, etc., and that when he suffered them to get any in their possession it was chiefly to serve his own ends by setting them and the rest of the world together by the ears about it." This notion proceeds from the damps that frequently kill those who work in the mines: and as to seeing the devil, it is only what we call the will-o'-the-wisp.

That remarkable and versatile Englishman, James Brooke, who founded the dynasty of English Sultans of Sarawak, opened diamond mines in 1840 in his future realm on the Santah River. He writes ("Narrative of Events in Borneo and Celebes," London, 1848, Vol. 1, p. 280-2), that, "The workers dislike noise, particularly laughter in merriment, as it is highly offensive to the spirit who presides over the diamonds, and, what is perhaps more important in their eyes, the diamonds cannot be found if the abode of quiet is disturbed by unholy mirth. It is surprising to see people calling themselves Mohammedans yielding to Pagan rites of presenting offerings to the spirit of the mine—the Gnome king: fowls, rice, eggs, ciri are weekly offered: but I was pleased to hear that they were sensible enough to eat up these good things after the oblations had been made. Hajji Ibrahim (a Chinese Mohammedan, S.H.B.), with the most solemn face, requested me to give him an old letter, and he engraved thereon some Chinese characters two inches long, which, being translated, signify "Rajah Muda Hassim, James Brooke, and Hajji Ibrahim present their compliments to the spirit and request his permission to work at the Mine."

Carl Bock ("Head Hunters of Borneo," second edition, 1882, p. 171) says that the Chinese believe that one variety found set uncut in a ring prevents certain diseases. This is called "inten boentoet," or "tail of diamond." Bock, had never heard it called "soul of diamond," as Dr. Schwanzer reports. "It is generally of a round form with a granulated surface, semi-transparent, of a grayish-black or grayish-brown color. The people all say it is so much harder than the ordinary diamond that they are unable to cut or polish it." Withal an excellent description of ballas, or spherical bort. W. R. Cattelle ("The Diamond," p. 218) adds, while the finding of such a stone is indisputable evidence that the miners' claim is exhausted, it will, if worn uncut around the neck, surely lead him to new and important deposits.

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Native women dry vanning for tin in Southwest Africa

Direction Lines for Drift Curves

K. L. Böckman

IN RAILWAY ENGINEERING the surveyor has a comparatively easy job in laying out curves of track. On the surface he can use the various chord and offset methods and always check his line before the actual work of construction starts. He runs no danger of losing his direction or running wrong curves. Even where he has to establish the direction lines of a curved tunnel, the task is fairly easy. Railway tunnels are broad and their curves on large radii, so that the change of direction is very slow. Any direction line, when fixed, rules for several days and gives the surveyor ample time for checking and correcting. At leisure he can put in the marks or plugs of a new line when the offsets from the old one render it difficult to direct the holes of the rounds.

In mine work, with its narrow drifts and short-radius curves, an entirely different set of conditions must be met. If the curves are run on tangential lines, the direction, usually, ought to be changed after each round. On chord lines a change may be necessary every two, three, or four rounds, depending on the amount of curvature, to avoid offsets injurious to the drill work.

The disadvantage of the offset system of directing curve lines is very clearly put forth by George A. Clayberg in the April, 1931, number of this magazine, on page 229. He shows how the miner, by the method mentioned, is given only the location of the center of the drift, but not its direction for each new round. Accordingly, he may drive on a wrong line, producing an incorrect curve that causes trouble and ill feeling.

Mr. Clayberg recommends the method of chords and deflection angles of equal or of variable magnitudes. It is a good system, inasmuch as it marks both the center of the curved drift and the direction of driving in every instance. The center line of the curve will be a polygon, having its turn points on the curve circle and its sides, the chords more or less closely adhering. But the way of making the survey, as recommended by Mr. Clayberg, is not the easiest one, according to my experience. His method calls for the use of a transit or a Brunton compass with set-ups and sights at each turn point of the curve. As the new turn point is always located close to the drift face, where either the muckers or the drillers are at work, the surveyor can hardly avoid being a hindrance to them whenever he visits the place to give a new directing line. Moreover, the calculation of a deflection angle is hazardous under these circumstances, when sitting on the muck pile and being under the impatient frown or low-breath utterances of

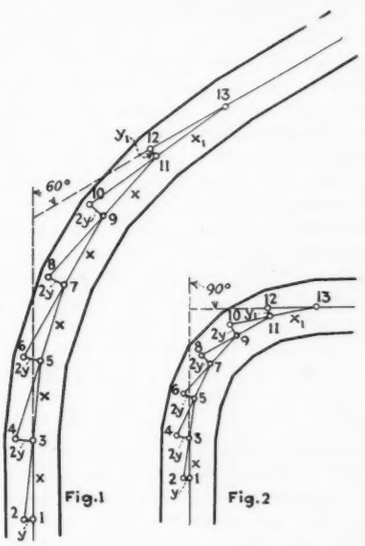


Fig. 1

Fig. 2

muckers or drillers on contract. These conditions assure no foolproof atmosphere for trigonometrical calculations.

In my opinion the following procedure (see Fig. 1) is far better:

The chords of equal length are selected about equal to or, if anything, a little shorter than a whole multiple of the average advance made by the usual round. This chord length, x, is governed by the width of the drift and the radius of curvature, being, for instance, in drifts of 2-m. width, a maximum of 4 m. on a curve of 20-m. radius, and 2 m. on a 5-m. curve, as found by drawing to scale or by calculation according to the formula: $x = 2yr$, where $2y$ is equal to half the width of the drift less 0.20 m. From point 3 on the center line, where curvature is to begin, as marked by the lamp on the face or the roof, measure backward along the center line the distance of a chord length and put a mark or a plug in the roof. From the plug or the suspended plumb bob measure at right angles to the center line in direction outward from the curve center a horizontal distance $y = x_2 \div 2r$ and mark the spot with a plug or otherwise (point 2). Points 2 and 3 give the first direction of deflection, which the center line has to follow for the length of a chord onward from point 3.

As soon as the first round in this new direction has been fired and the muck has been cleaned away, the surveyor may fix point 3 permanently, simply by measuring forward the length of a chord from the previously fixed point 1. A plug or other mark in the roof will be out of danger from the next round, and the miner has his two fixed direction points. After driving the length of a chord, a new direction must be given. From point 3 to the first chord direction and outward from the curve the distance of $2y$ (point 4) is measured normally. This point and the lamp mark at the end of the first chord (point 5) give the direction of the second chord, which is to be followed for another chord length. The turn point 5 is fixed as before, after the round has been fired.

This manner of procedure is followed until the end of the curve, the offside distance of $2y$ being measured at the turn points. At the curve's end the new straight direction of the drift is once more on a tangent, as was the old direction before the curve started. This new direction therefore is fixed by measuring only the distance of y to the side at the turn point next to the last (point 11). Often the last turn point, the curve's end (13), will not be at the exact length of a chord from the next to the last. A small difference does not matter; only y has to be calculated separately for this special value of x. The resulting error, because the last turn point will be located a little off the exact curve circle, is negligible, but it can be avoided by selecting the chord length exactly equal to an even part of the curved, polygonal center line. It is of no importance, however, the greater consideration being to have x as nearly equal to a whole multiple of the average advance of a round as possible. The chord length is limited by the y value. Theoretically the measure $2y$ may be taken equal to the distance of the drift side from the center line, but practically it must be at least 0.20 m. less, to leave that much space for sighting purposes.

The method is only an approximate one, but is exact enough for all practical purposes. The error as found by drawing to scale amounts to about 1 per cent, making the curve that much sharper. For greater exactness a transit survey line may be run behind to detect and rectify any small error, and such survey is certainly necessary to put the drift on the exact direction wanted beyond

the curve. The great advantage of the method is that no instrument set-up and no angle measurement are necessary. Everything is measured by a tape and a square hook, and the work is done so far behind the face as not to interfere with drilling operations.

Consider, now, a curve of 60 deg. on a radius of 15 m. (Fig. 1). The length of the curve center line is $15 \times 60 \times \pi \div 180 = 15.7$ m.; the polygon length slightly less—say 15.6. The average round advance amounts to 5 ft., or 1.53 m. A chord length of two rounds gives $x = 3.06$, $y = 0.31$, and $2y = 0.62$, which leaves ample room for side measurement and sighting. A length of $2\frac{1}{2}$ rounds might also suggest itself, finishing the curve in four chord lengths of 3.82 m. each. But the calculation shows $2y = 0.97$, which is too much. Accordingly, a chord length of two rounds is decided on and the desired curve will be obtained by five turn points. Plugs or marks are measured and put in as mentioned in the foregoing and in the order shown in the figure. Any driller of average intelligence will soon learn how to measure chord lengths and offsets according to the instructions given him, so that he marks his own direction points provisionally, and the surveyor need not be present at every change of direction. This saves waiting time and trouble for both. When the presence of the surveyor is necessary, he can arrange to be notified in good time by the driller, so that he will be on hand at the right moment for fixing a new direction line and avoid losing his own time and that of the driller.

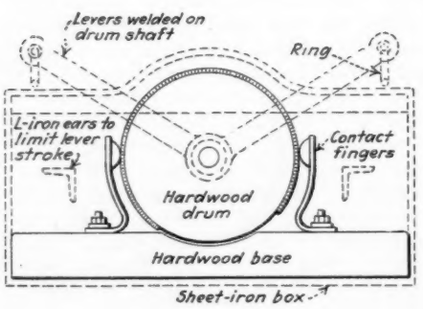
Fig. 2 shows the running of a curve of 90 deg. on a radius of 5 m. in a drift of 2-m. width and making an advance of 1.50 m. per round. The chord length corresponds to one round and the offside measurement $2y = 0.45$ m. The direction must be changed every round, but the chords and offsets will easily be measured provisionally by the driller.

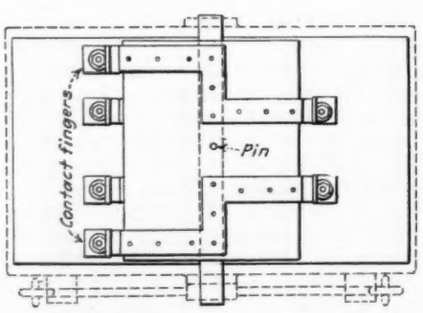
A system of variable chords and offside measurements may also be used. It is best suited to curves of long radii, where any one settled direction lasts for a considerable time—say three or four rounds at least—but may be adapted to most conditions encountered. The curve is drawn in the office on strong paper to a large scale—1:20, for instance—nailed to a board plate, and kept in the mine. The maximum advance before necessary change of direction is fixed, and the driller advised to give notice in good time before passing it. When visiting the place to change direction, the surveyor or boss brings his drawing, measures the advance from the last plug or mark, and draws it to scale on his map. At full advance the chord line will just reach the curve circle at the new turn point. At less, the chord's end will be a trifle inside the circle. At more it will be a trifle outside, and the new turn point may be rectified accordingly, if necessary. The new chord line is drawn and its corresponding offside value is scaled off and measured in the usual way from the last turnpoint. In my opinion this graphical method is inferior to the other, entailing more work at the face and being more liable to errors. Graphical in a way is the other method also, because the curve should always be drawn in advance in the office by the calculated chord and offside measurements to see that the curve thus constructed corresponds nearly enough to the desired one.

I think the method here detailed and illustrated is practical, easy, and causes a minimum of interruption to the workers. Its usefulness and approximate exactness, by whichever circular curve, will be shown on trial on drawing paper. A disadvantage may be the many plugs required to be put in, the work and difficulty of having them located exactly, and the nuisance of having them mixed up with the regular survey plugs. It can be avoided, however, by using tar or paint marks instead of plugs, as they are accurate enough for the drillers' work. The surveyor, in running his line behind them, will have to correct any serious error.

■ ■ ■

Four-way Signal Switch





AN IMPORTANT consideration in the design of a haulage signal system is the control switch installed at various underground transfer points. A switch of the knife-type is generally used. As long as care is exercised by the operator, no trouble is experienced; the passing trainman will, however, often pull the switch too vigorously, and break the base, knives, or contacts. Costly repairs are then necessary. To overcome this difficulty, and avoid interruption of haulage operations, M. F. Murphy, chief electrician at Old Dominion, Globe, Ariz., developed the switch shown in the accompanying sketch. It is constructed after the principle of a drum-type controller, with contact segments of $\frac{1}{16}$-in. sheet copper mounted on a hardwood drum, pretreated in linseed oil, and six factory-made contact fingers attached to the wooden base. The operating mechanism of the drum consists of an angle lever, welded on the drum shaft, equipped with two small rings at the ends for the pull cables. The complete switch rests in a neat safety box, made of $\frac{3}{32}$-in. sheet iron. The two sides of the box, which are equipped with small bearings to accommodate the drum shaft, are reinforced with $\frac{1}{8}$-in. material. To limit the lever stroke, two angle-iron ears are provided on the front wall of the box, as shown.

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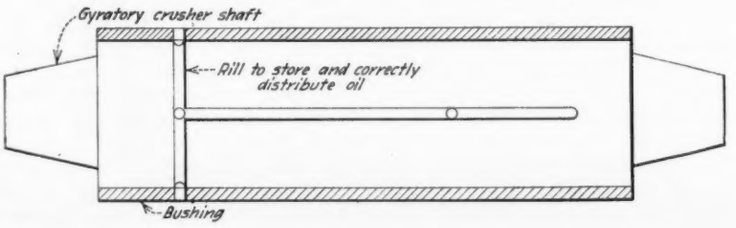
Gyratory Crusher-Shaft Repair

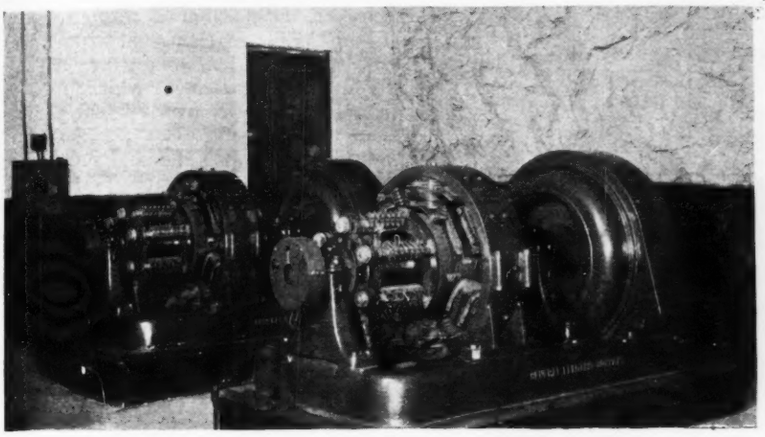
CONFRONTED with the problem of rapid wear of gyratory-crusher parts, the mechanical department at the concentrator of the Moctezuma Copper at Nacozari, Sonora, Mexico, recently found, after a careful investigation, that insufficient and misplaced oil grooves caused faulty distribution of oil to the shaft bushing and adjoining parts. This difficulty was overcome successfully by providing a storage and distributing rill on the crusher shaft, as shown in the accompanying sketch.



Electricity in Limestone Mining

F. P. Brightman

Industrial Engineering Department, General Electric Company, Schenectady, N. Y.



Two 22 kw., 275-volt synchronous motor-generator sets with automatic control

A DOUBLE-UNIT, completely automatic substation was recently installed at Pittsburgh Limestone Company's Buffalo Creek mine, near Worthington, Pa., to supply direct current to the mine haulage system, and for general use in the mining operation. Synchronous motor-generator sets were selected on account of their greater flexibility in the control of the d.c. voltage and their independence of the fluctuations of the a.c. system voltage which affect the d.c. voltage when converters are used. Another factor in favor of the motor-generator sets is that the leading reactive kva. from the synchronous motors of the sets helps to raise the power factor of the load in the mine, thereby improving operating conditions and decreasing the power bill.

The sets and their control equipment are installed in an underground room 75x35 ft., 12 ft. high, blasted out of the solid limestone rock. The side walls and the roof consist of the natural rock; the end walls are made of concrete and have two windows and a door each, normally left open for ventilation. About half of this room is occupied by air compressors.

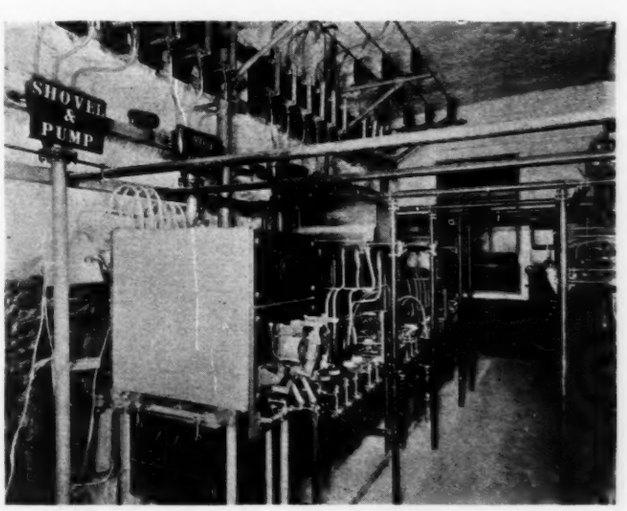
Ventilation in the mine is entirely by natural draft through the extra large entries and 20-in. drill holes throughout the mine. Although no appreciable current of air is evident, as is the condition where forced ventilation is used, the circulation is good and the machines run cool at all times. The substation is very dusty, but this does not seem to affect the relays or the commutators of the machines.

Power to the substation is supplied by a three-conductor, 2,300-volt, 300,000-circ.mil varnished-cambric, lead-covered cable, suspended from the roof of the mine entry. An attendant in the room looking after the compressor, starts and stops the two units as required; otherwise they are completely automatic in their operation, affording maximum reliability and protection.

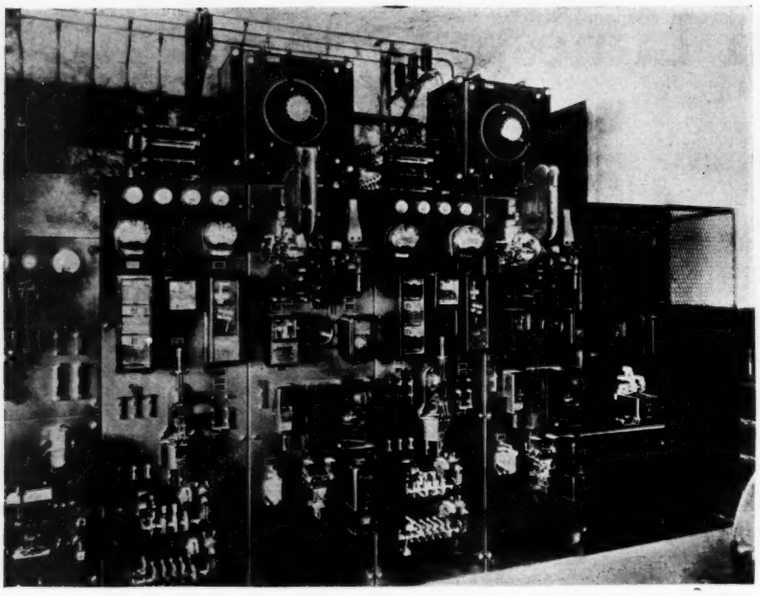
The switch gear is so arranged that partial voltage is applied to the motor when starting conditions are right and the master switch is closed by the attendant. During the starting period, a contactor shunts a portion of the generator field rheostat, insuring speedy build-up of the voltage. The generator voltage has built up by the time the synchronous-speed relay indicates that 95 per cent full speed has been reached; then the field contactor closes, putting full field on the synchronous motor, with the generator as a source of excitation power. The motor is then connected to full line voltage. When the generator voltage has attained a value slightly in excess of that of the bus, or a definite figure in case the bus is dead, the main generator contactor is closed, connecting the machine to the line. This operation is controlled by the reclosing equipment which "feels out" the circuit to make sure that load conditions are correct before the line contactor is permitted to close.

The control equipment is so arranged that the starting indication can be given locally or from a remote point. Originally the intention was to start one of the sets with a remote-control switch at the tipple when the first train of empties was ready to enter the mine. This feature has not been used extensively, however, inasmuch as the man who has to be present all the time to tend the compressors was instructed to start the set at a fixed time. Load-responsive equipment for starting and stopping the second set on load demand was not provided, as the mine load is of such a nature that the second set is needed during certain definite periods when it is started and stopped by the attendant.

Special regulating equipment was provided to insure satisfactory load balance between the two generators. This equipment consists of a balanced armature relay with both coils connected across a portion of the commutating field of the generators, one coil on each machine. Under normal operating conditions, with the load balanced between the machines and equal currents flowing through the two commutating fields, producing an equal voltage drop across each coil, nothing happens, but if for any reason the load becomes unbalanced, the drop across one coil becomes greater than that across the other, and the relay then closes its contacts on one side or the other, according to the way the load



High-tension bus and starting equipment for two motor-generator sets

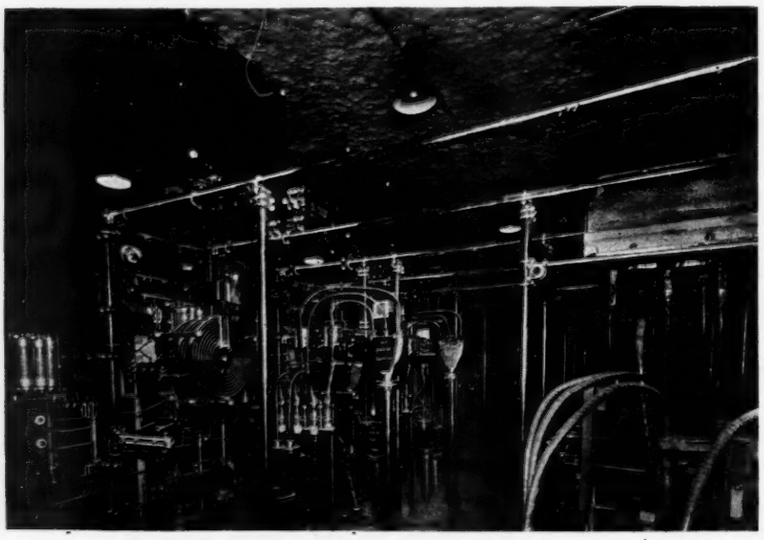


Automatic switching equipment for two motor-generator sets

is unbalanced. Closing of the relay contacts causes a part of the field rheostat of one of the generators to be shunted by a contactor to raise or lower the voltage as the load is too low or too high. In this way one of the machines is made the master while the other balances the load. Provision is made for automatic closing of the equalizer connections between the generators when the second set is started.

The automatic switchgear provides protection by preventing start of the motor (*a*) when the a.c. line voltage is too low; (*b*) when single-phase power only is available on account of a break in the line; or (*c*) when a reversal of phase rotation has occurred. Once the set is started, protection is provided by a temporary shutdown in the event of low a.c. voltage, badly unbalanced current in any of the phases, or a moderate, prolonged overload, sufficiently high to cause overheating of the motor winding but not enough to trip the over-current relays. This protection is afforded by a thermal relay designed with the same heating characteristics as the motor, when installed under the same conditions of ambient temperature.

If for any reason starting sequence is not properly completed, the set is shut down and locked out until the operator resets the "incomplete start" relay. The set is also shut down and locked out (*a*) if a short circuit occurs on the a.c. side; (*b*) if the synchronous-motor field fails; (*c*) if the set overspeeds from failure of the a.c. power supply when operating in parallel with another d.c. machine; (*d*) if bearings became overheated; or (*e*) if unbalanced phase current occurs during the starting period.



Automatic switching equipment—rear view

The generator end of the set is protected by overload- and reverse-current relays which disconnect the machine from the line if either condition occurs. As soon as proper conditions are indicated by the "feeling-out" equipment, however, the machine is reconnected to the line. This "feeling-out" equipment consists of a load-indicating resistor and a reclosing element which includes in one device d.c. over-current indication, the reclosing relay for stub and multiple operation, and a definite time relay. The load-indicating resistor is connected across the contacts of the main-line contactor; when the latter is opened on over-current, the load-indicating resistor is inserted into the circuit, permitting a current of predetermined value to flow into the load or short-circuit. The relay for reclosing on stub-end feed has two coils, one of which (the field coil) is connected across full line voltage, the other (the operating coil), across the load. The reclosing relay for multiple operation is connected to read the voltage across the load-indicating resistor; that is the difference between the generator voltage and line voltage.

When a short circuit in the system causes the main line contactor to open, the load-indicating resistor permits current to flow into the load. As long as the short circuit or a severe overload persists, the voltage across the load coil of the reclosing relay is low and the combined effect of the two coils is insufficient to make the relay close its contacts and reclose the main-line contactor. When the trouble is removed and the resistance of the load circuit increases, as indicated by the voltage drop across the operating coil, the cumulative effect of the two coils is sufficient to close the relay contacts, which in turn close the main contactor.

In the event of a short-circuit or an extreme overload occurring when the machine is operating in parallel with another machine, the other reclosing relay with its coil connected across the load-indicating resistor checks the voltage between the machine and the rest of the system. As soon as this voltage has decreased sufficiently the relay closes its contacts and permits the main line contactor to close. A selective relay determines whether the equipment is functioning under stub-end or multiple-feed operation conditions.

The blasting charges used in the mine are heavy because the nature of the rock is such that great force is required to break it. Every afternoon at 4:30 when blasting begins all electric power in the mine is shut off as a safety measure. The sets are usually not restarted until the following morning. The force of the blasts is so great that the windows in the substation are broken and the walls are severely shaken if the doors are closed on one side and left open on the other. In spite of this rough treatment, the automatic equipment continues to function satisfactorily.

COST OF MUCKING

Morris J. Elsing

SAND SHOVELING is still a very important part of most underground operations, although modern mining practice is tending to do away with it as far as possible, both by the application of mining methods which largely eliminate shoveling, and also by the introduction of mechanical mucking. Scrapers have been most successful in stoping operations and in driving the larger haulage drifts. Many mines have experimented with different types of loaders, but so far no very satisfactory mechanical device has been found which will replace the hand mucker in the smaller drifts and tunnels and in mining some of the smaller orebodies. Whenever sorting underground is necessary, the hand mucker is supreme.

The cost of mucking is such a large proportion of the usual total mining cost that it deserves careful consideration with the idea of trying to fix a general figure which can be regarded as being in accord with good practice.

Mucking and tramming are usually so intimately related that the two operations cannot be sharply distinguished. Mucking into a wheelbarrow or car necessitates tramming. If the distance trammed is short, it is a rest period in a certain sense, as it permits a cessation of the hard work of shoveling. This pause, along with the change in character of the work, does not proportionately affect the output of the mucker.

For most contract mucking the price includes the tramming of the loaded car to a switch or siding, from which point it is handled by mules or motors. The length of this tram varies, in the cases for which costs are to be cited, so that the shoveling costs are not exactly comparable.

In 1918, a complete investigation regarding shoveling at Tyrone, N. M., was made by G. Townsend Harley[1]. At this mine it was found that the actual working day was not 8 hr. but 6 hr. and 12 min. The difference, representing non-productive time, consisted of a lunch period of 30 min. and 1 hr. and 18 min. for lowering the men into the mine, distributing them to their working places, and hoisting them again.

Tests showed that the greatest efficiency was obtained by using a shovel of high-grade steel, weighing 5 lb. 8 oz. and capable of holding 21 lb. of material. The results of these tests made throughout a whole year are of such interest that a summary of output and costs is given in Table 1.

This table shows that 12 ft. is the maximum distance that ore should be thrown into a chute. (This distance is 2-4 ft. longer than that usually recommended.) At a distance of 12 ft., 22 tons can be handled per shift at a price of 16.3c. per ton. If the distance exceeds 12 ft., a wheelbarrow is more economical. When the wheelbarrow tram is over 35 ft., at which distance 19.6 tons is moved at a cost of 19.1c. per ton, a car is more economical. When shoveling into a car and tramming it 100 ft., 17.5 tons was moved at a cost of 21.4c. per ton. When shoveling from within 2 ft. of the chute, a maximum of 31.5 tons was moved at a cost of 12c. per ton.

At an iron mine on the Marquette Range iron ore is shoveled on a contract basis. Converting these rates to short tons, we have the following:

Table II—Contract Shoveling Rates, Marquette Range

	Cents per Ton
Large piles	16.9
Stopes	18.6
Drifts	20.4

In the Southeastern Missouri district the usual task or "score" for a shoveler is 20 tons per shift. This includes tramming to a siding, ordinarily using a mule. The cost is about 25c. per ton.

In Bureau of Mines Information Circular 6113, the cost of hand shoveling at the "No. 8" mine, St. Louis Smelting & Refining Company, Southeastern Missouri district, is given as ranging from 25 to 28c. per ton.

At "Mine No. 2," Tri-State district, Picher, Okla., mucking is done by hand shoveling into cans which are set on small trucks. Muckers are paid 11c. per can of 0.6 tons, or approximately 18c. per ton. A short tram is included in this contract. Where working under adverse conditions the pay is as much as 23c. per ton. The average experienced mucker will fill 40 or more cans per shift and a few will average 100 cans, or 60 tons, per shift. At the Barr mine, in the same district, hand shovelers load 25 tons per shift and receive on the average 25c. per ton. Shoveling is done from 2-in. plank.

At the "No. 3 Mine," Tri-State district, Crestline, Kan., muckers are paid 10.5c. per can of 0.6 tons' capacity. This is at the rate of 17.5c. per ton. An experienced man will load from 24 to 48 tons per shift.

Shoveling costs in four mines in the Wisconsin zinc district averaged 19c. per ton in 1927. The actual contract price was 14.5 to 15c. per ton.

Table III (next page) shows a summary of the cost of hand shoveling in various parts of the United States.

The figures in the accompanying tables are not exactly comparable.

Table I—Shoveling Cost, Burro Mountain Copper Company, Tyrone, N. M.

Distance Ore Is Thrown or Conveyed, Feet	Shoveling Into Chute: Average Tonnage Expected	Shoveling Into Chute: Payment Rate for Average Per Ton	Shoveling Into Wheelbarrow: Average Tonnage Expected	Shoveling Into Wheelbarrow: Payment Rate for Average Per Ton	Shoveling Into Car: Average Tonnage Expected	Shoveling Into Car: Payment Rate for Average Per Ton
2	31.5	$0.120	....	.....	....	.....
3	31.0	.121	....	.....	....	.....
4	30.0	.125	....	.....	....	.....
5	29.5	.128	....	.....	....	.....
6	29.0	.130	....	.....	....	.....
7	28.0	.134	22.7	$0.165	....	.....
8	27.0	.139	22.7	.165	....	.....
9	26.0	.144	22.7	.165	....	.....
10	25.0	.150	22.6	.166	19.5	$0.192
11	24.0	.156	22.6	.166	19.5	.192
12	23.0	.163	22.6	.166	19.5	.192
13	22.0	.170	22.5	.167	19.4	.193
14	20.0	.188	22.4	.167	19.4	.193
15	19.0	.197	22.3	.168	19.4	.193
16	18.0	.208	22.1	.169	19.4	.193
17	17.0	.220	22.0	.170	19.3	.194
18	16.0	.235	21.8	.172	19.3	.194
19	14.0	.268	21.6	.173	19.3	.194
20	13.0	.290	21.5	.175	19.3	.194
25	....	.....	21.0	.178	19.2	.195
30	....	.....	20.3	.184	19.1	.196
35	....	.....	19.6	.191	19.0	.197
40	....	.....	18.8	.199	18.9	.198
45	....	.....	18.0	.208	18.8	.199
50	....	.....	17.3	.217	18.7	.200
60	....	.....	16.4	.228	18.4	.204
70	....	.....	....	.....	18.2	.206
80	....	.....	....	.....	18.0	.208
90	....	.....	....	.....	17.8	.210
100	....	.....	....	.....	17.5	.214

This is the second of a series of articles on the cost of mining in the United States.

[1]Efficiency engineer, Phelps Dodge Corporation, Burro Mountain Copper Company Branch. "A Study of Shoveling as Applied to Mining." Trans. A.I.M.E., Vol. 61, 1919.

Some show total costs of shoveling, including supervision, but most of them are contract prices. The tramming items vary considerably, as well as the general working conditions. However, several interesting conclusions can be drawn. The total cost of mucking in top-slice stopes at Miami is shown as 16c. per ton, which includes supervision. The figure is closely comparable with the contract price at Mascot and in the Wisconsin district. This is of interest because at the three places the labor is Mexican, colored, and white, respectively, despite which the costs vary but slightly.

Condition of the working place will affect shoveling cost and efficiency more than any other underground factor. Unfavorable water conditions will cause an increase of from 10 to 20 per cent in cost. Air conditions will affect costs. The physical exertion required by shoveling is greater than any other class of work underground. In drilling, the physical exertion of setting up the drill column and mounting a drill is considerable. Similarly, in timbering, certain parts of the work require great physical effort. However, in neither of these operations is this output of effort so constant as in mucking, and, besides, the character of work is more variable and, therefore, less trying. Hot air, if reasonably pure, will cut down the shoveling output considerably, but when the air is both hot and impure the results become very unsatisfactory.

One of the most difficult tasks in mucking is the so-called mucking back in driving a drift. In this work, the mucker stands directly over newly blasted muck and, as the shoveling progresses, the powder gases released add greatly to his discomfiture.

Character of the material shoveled has an important effect on output. Of all the different classes of material that are mucked a sticky, clayey mass is the most difficult to handle. Large hard boulders, which have to be broken before being shoveled, slow up the rate. When sorting is required in addition to boulder breaking, the output per shovel shift is low. Mucking from plank or steel sheets is much more efficient than from the rough.

Length and height of throw have an important effect upon output. The effect of the length of throw is shown by the figures in Table I. An increase of one foot in this length decreases the amount shoveled per shift approximately 1 ton. A ratio also exists between the tonnage shoveled and the height of the throw. The average man is capable of producing only a certain number of foot-pounds per shift, and on this theoretical assumption his shoveling capacity is reduced approximately 15 per cent for each additional foot in the height of throw. However, the per-foot decrease of capacity is less marked between shoveling into a wheelbarrow and a mine car, and in this case it amounts to from 8 to 10 per cent per foot of lift.

Table III—Summary of Hand-Shoveling Costs

Location	(a)	Tons per Shift	Cents per Ton	Year	Remarks
Burro Mountain Copper Co., Tyrone, N. M.	A.I.M.E. Vol. 61	31.5	12.0	1918	2-3 ft. from chute
		22.0	16.3		12-ft. from chute
		19.6	19.1		35 ft. wheelbarrow tram
		17.5	21.4		100 ft. car tram
Miami Copper Co., Miami, Ariz.	A.I.M.E. Vol. 55	20.0	16.0	1916	Total cost
Old Dominion, Globe, Ariz.	.....	21.0	23.4	1930	Stopes
		18.0	27.5		Drifts
United Verde, Jerome, Ariz.	A.I.M.E. Vol. 66	....	46.0	1921	Stope cost, including boulder breaking
United Verde, Jerome, Ariz.	M.C.J. 4/30	20.0	29.0	1929	Stopes
Iron mine, Marquette Range, Mich.	I.C. 6138	26.0	16.9	1929	Large piles, contract
		....	18.6		Stopes
			20.4		Drifts
Mineville, N. Y.	I.C. 6092	....	29.0	....	Loading and tramming
Mascot, Tenn.	A.I.M.E. Vol. 48	15.7	15.0	1917	Colored labor
Mascot, Tenn.	A.I.M.E. Vol. 72	16.8	13.5	1925	Contract price Colored labor
Wisconsin zinc district	A.I.M.E. Vol. 59	....	16.0	1917	Bulgarians, Slavs, Poles, Russians
Wisconsin zinc district	A.I.M.E. Vol. 53	32.0	13.3	1919	Contract price. All mines
Wisconsin zinc district	M&M July, 1928	24.0	14.5	1928	Contract price
		24.0	19.0		Total cost
Southeast Missouri	I.C. 6170	20.0	25.2	1929	Including tram. Day's pay
Southeast Missouri, No. 8 Mine	I.C. 6160	21.0	25.6	1929	Contract and company account
Mine No. 1, Tri-State	I.C. 6113	35.0	15.0	1929	Contract price from large piles
Mine No. 2, Tri-State	I.C. 6121	24.0	20.0	1929	Including tram
Mine No. 3, Tri-State	I.C. 6174	24.0	17.5	1929	Tramming distance 400 ft.
Barr Mine, Tri-State	I.C. 6159	24.9	26.0	1929	Contract price
Hartley-Grantham, Tri-State	I.C. 6286	29.3	20.0	1929	Contract price
Waco, Tri-State	I.C. 6150	....	15.7	1929	Contract price
Joplin district	Peele's Handbook	....	17.2	1908	
		....	21.2	1909	
		....	19.6	1910	
			20.0	1911	
			22.6	1912	Including tram
Joplin district	A.I.M.E. Vol. 57	20.0	15.5	1912	
			14.7	1913	
			21.0	1915	
			23.4	1916	
Rosiclare, Ill.	I.C. 6294	....	24.0	1929	Tram 500 ft. contract price
Baldwin, Burma, India	A.I.M.E. Vol. 69	4.6	8.6	1921	Stopes

(a) I.C. 6113 refers to U. S. Bureau of Mines Information Circular No. 6113; A.I.M.E. refers to the Transactions of American Institute of Mining and Metallurgical Engineers; M.C.J. refers to *Mining Congress Journal*.

The rate of mucking in shafts has been greatly increased by the use of shallow steel boxes instead of buckets. In the main, this increase is due to the reduction in the height of throw. Whenever mucking is done from the top of a pile, the work is more difficult, but this is necessary in a shaft. Speed necessitates that as many men as possible be employed in mucking, and the result is that the men do not have the freedom of movement that is usual in most other mucking operations. As a matter of fact, shaft mucking is entirely different from mucking in a drift. In the latter operation the mucker stands with his back to the car he is loading and he throws the muck over his shoulder. In a shaft this is seldom done. The usual practice is for the shaft bucket to stand in the middle of the shaft and for the muckers to take positions around it and facing it. The throw is straight ahead into the bucket, but for some of the men the throw is sideways. When a position facing the bucket is taken, the mucker occupies the smallest amount of space, thus permitting more muckers to work. In this position he is working under difficulties, but the output per man-shift is sacrificed to gain speed in sinking. Under the conditions of shaft sinking a low lift is especially desirable, and this obtains when a box is used instead of a bucket.

On the basis of the figures presented, with adjustments and allowances for miscellaneous charges, the approximate cost of shoveling is as follows: Copper mines, 28c. per ton; iron mines, 20c.; Tennessee, 18c.; Wisconsin, 19c.; Southeast Missouri, 24c.; Tri-State district, 20c.; and Illinois, 24c.

In the Wisconsin district, the contract price is 15c., but the total cost of shoveling is reported as 19c. per ton. This latter figure covers supervision as well as incidental miscellaneous shoveling expense.

The present average cost of mucking in the United States is approximately 22c. per ton. This figure is representative of mucking in stopes and from the larger piles. It does not include the cost of mucking in drifts and shafts, which is considerably higher. This cost includes only a minimum amount of boulder breaking and, when done on the level, includes a short tram only. The Western copper mines show the highest costs, and the zinc mines of central United States show the lowest. In large part, this is probably due to the fact that the mines in the last-named district, being shallow, naturally have better ventilation.

The cost of shoveling at the Burma Corporation's mine is also shown in Table III. In 1921 the output was only 4.6 tons per man-shift, with a cost of 8.6c. per ton. This is a striking illustration of the effect of cheap foreign labor which obtains in certain parts of the world.

IN THIS ARTICLE a well-known Canadian engineer again seeks to curb the enthusiasm of those who publicly resort to exaggeration in discussing the possibilities of the Canadian mining industry. He feels that Dr. C. V. Corless, in his presidential address to the Canadian Institute of Mining & Metallurgy in 1922, erred in his argument that the mineral wealth of Canada could be described as "inconceivable," "illimitable," or "inexhaustible." . . . Canada, argues Mr. Campbell, would be better off were it to face facts; and the main fact, as he sees it, is that the two million square miles of Pre-Cambrian granitic rock, representing almost the whole area of central, eastern, and northern Canada, contains no more than 10 per cent of favorable prospecting ground—covered by sedimentary rocks and igneous intrusions. Some of the principal districts in which such rocks occur were mentioned by Messrs. Arnold and Robert D. Hoffman in an article in these pages a few months ago. . . . Over-optimism is a characteristic of pioneers; it transcends their intelligence and leads them to places and into difficulties that would otherwise seem unattainable or insuperable. Fortunately, and naturally, we find the rainbow more attractive than the dark clouds. To err is human. In this twentieth century, few examples can be found of restrained sanity and adherence to the strict truth among those who want to persuade others to spend money. Among such, the printed word is well recognized as being subject to a liberal discount. So the statement that the iron industry at Churchill will compare with that of Pittsburgh, and that about the fourteen billion tons of copper ore near Coronation Gulf, will hardly fool any one. And yet, engineers, even though they be extroverts, cannot afford to take too many liberties with the English language. "Inconceivable," "illimitable," and "inexhaustible" are dream words that should not be in their vocabulary when talking about ore deposits in any country, even Canada.

Strip of river bank showing rock exposed

PRE-CAMBRIAN PUBLICITY

C. M. Campbell

IN AN ADDRESS delivered in eastern Canada in 1930 a high mining authority said that "At Churchill we will have an industry in iron that will compare with Pittsburgh." He pointed out that the country surrounding Churchill, in Manitoba, on Hudson Bay, contains large deposits of valuable iron and coal; that the northern part of the region mentioned holds one of the largest copper mines ever found. A statement of this importance, naturally telegraphed from one end of the Dominion to the other, received adequate prominence in the newspapers. This was followed later by an editorial, in a western Canadian daily, in which a railway was advocated to Liard, in the Mackenzie district in the Northwest Territories, from which point summer navigation to the Arctic is possible. One of the reasons advanced for the building of this road is that it will tap "At least 14,000,000,000 tons of copper ore, more than in all Rhodesia, near Coronation Gulf."

These announcements have met with no criticism from Canadian mining engineers. Similar estimates of positive reserves, made by mining men in the Dominion, are still in effect, illustrating an established procedure whereby any desired conclusion is published, the facts supporting it being obtained later, or never.

Some time ago I prepared an article dealing with publicity of this sort concerning the Canadian Pre-Cambrian. It was written to controvert the positive publicity that Canada contains inconceivable wealth in minerals, the Pre-Cambrian being the chief argument for that claim. The article, published in the Aug. 4, 1928, issue of *Engineering and Mining Journal*, was the subject of considerable comment, and the matter was recently revived in a paper entitled "Pre-Cambrian Conceptions," written by Arnold and R. D. Hoffman, which appeared in this journal last April. It is not my intention to go into unnecessary repetition, but two points that have been advanced warrant further attention, and some publicity methods require, in my opinion, reference and comment.

No apology is offered for referring to the matter again. The mineral resources of Canada are not merely of local interest; they have a vital bearing on the welfare and the future of the entire world, the same as important mineral resources of many other countries. The amazing increase in the consumption of metals in the last quarter century, the rapid depletion of the world's ore reserves, and the fact that the peak of production is considered to have been passed in the United States, have sent engineers scurrying into the remotest parts of the world. Naturally, the result has been a temporary overproduction, and research men are working overtime finding new uses for metals. The fact that the world has been taught to use more and more metals implies an obligation on the part of mining men to supply its needs, and remote sources are being examined for an adequate supply.

Thanks to the success of publicity efforts in Canada, a belief is held by many inhabitants of the dominion that "The destiny of Canada lies hidden in the Pre-Cambrian"—that this is the promised land from a mineral standpoint, and that the world will have to come to Canada for its mineral needs. Present-day efforts, as the initial para-

graphs of this article indicate, continue along that line. Remarks such as I have quoted have been supplemented by the reiteration by public men of the usual statement in regard to inexhaustible reserves. In a few cases this statement has been qualified by the word "almost"—a qualification that has no meaning. As much difference exists between "inexhaustible" and "almost inexhaustible" as there is between a unit and a decimal-nine repeater.

I have pointed out that much of the Pre-Cambrian can be prospected with the greatest ease; that, although prospecting in the clay belts is difficult, the Pre-Cambrian certainly cannot be described as "hardly scratched," to use a popular expression, for the myriad lakes and rivers covering this great area have washed bare tens of thousands of miles of rock exposures; and that, in many inland sections, rock exposures are common. "This statement of mine," readers were told by one critic, "verges on the foolish." My statement was also strongly denounced in Canada; and the Hoffman paper, although admitting that some exposures are due to the "sinking of the water level in river or lake," refers to the Pre-Cambrian as among the most difficult prospecting areas in the world. "Deeply overburdened, heavily forested, covered largely by swamp, muskeg and water, it offers comparatively few outcrops," is the verdict of the paper referred to. This criticism is unwarranted at this time. Engineers who protest against a conclusion that a considerable section of the Pre-Cambrian is easily prospected should have filed their objections when the matter was discussed by Dr. C. V. Corless many years ago, when the bare nature of much of the Pre-Cambrian was used as an argument for the easy and rapid acquirement of fabulous riches. Doctor Corless, in the transactions of the C.I.M.M. for 1922, p. 24, says:

> "When nature transported the soil from this half of Canada to situations climatically more suitable for agriculture she balanced the loss to future generations by making possible the discovery of inconceivable mineral wealth. . . . Nature generally does not easily reveal her secrets, but in this instance she left the door half open."

These conflicting statements—that prospecting is easy and that it is very difficult—can be reconciled when it is understood that they apply to different parts of the same area. The facts are, therefore, that the Pre-Cambrian was scraped bare in some parts, and the soil deposited, as clay belts, in other sections. In 1903 a railway was being pushed northward, to open up one of these clay belts for agricultural purposes, when it struck silver ore at Cobalt. Porcupine, Kirkland Lake, and Rouyn were later discovered in this clay belt. Prospecting conditions in this section are covered by the Hoffman quotation. That this clay belt was not dumped on another lot is particularly unfortunate, for the great Pre-Cambrian reserves, as now known, are located mainly in the comparatively small section that contains Sudbury, Cobalt, Porcupine, Kirkland Lake, and Rouyn, much of this area being covered by glacial deposit. Other and rich orebodies that doubtless lie under this (generally) deeply overburdened area will probably never see the light. More intensive prospecting is warranted in places where this is possible, justifying the hope that other deposits, in addition to the recent Ashley find, will be made.

Two photographic reproductions are presented herewith, showing conditions in more easily prospected sections. One is an airplane view of a network of rivers and lakes, with an area of rock exposures in the foreground. The other shows a detail of the shore line. Bearing in mind the fact that a major ore deposit may have an outcrop half a mile long, the engineer and the prospector will realize that, with the network of waterways existing, the chances are good that a waterway, exposing the formation, will intercept many of the outcrops, if existing. The fact should be kept in mind that, after many years of prospecting in these sections, few interceptions have been located.

North of a line joining Churchill and the mouth of the Mackenzie River is a large section that is not forested, for it is north of the timber line. South of this line, for some distance, the timber is small and scarce. In the part tributary to Hudson Bay three exploring companies equipped with airplanes, spent two years recently in prospecting work. They examined a large number of outcrops, yet only one small deposit was found that justified further work. This was described by John Drybrough in the March, 1931, issue of this journal, and photographs were reproduced showing the character of the country in that part of Canada.

Considerable work has recently been done in the area about Great Bear Lake and the Coppermine River, where rock outcrops are reported to be common. In this section some encouraging finds have been made, but no tonnage has yet been opened up.

The second point in relation to the matter under discussion deals with the statement in the Hoffman paper to the effect that mines in the Pre-Cambrian are confined largely to the Huronian and Keewatin formations, which comprise only about 10 per cent of the entire Pre-Cambrian. This is a point for which I have endeavored for ten years to obtain recognition in Canada, but without success. In my article I placed this figure at 15 per cent. An official argument used in the Dominion is that such districts as Sudbury, Cobalt, and Porcupine occur in the Pre-Cambrian—an area of 2,000,000 square miles. Therefore, ore will be found "anywhere and almost everywhere," as a Canadian paper puts it, in that great area. The truth is that Sudbury, Cobalt, and Porcupine occur in Huronian and allied rocks covering an area of 200,000 square miles. The remaining sections of that area not already examined are good for prospecting. They may or may not produce ore deposits.

The difference between the two statements is great. If the former were the correct one we would now have, roughly ten Sudburys, ten Cobalts, ten Porcupines, whereas we now have only one of each. Recent finds would include ten Sherritt Gordons and ten Norandas instead of one of each, and future prospects would be ten times as bright. Even this would not represent inconceivable wealth, but I would oppose no such claims, if made, did the conditions outlined prevail.

The Pre-Cambrian is a group of formations, just the same as is all the area of Canada. No more justification exists for saying that the Pre-Cambrian is a uniform formation than to say that all Canada is a uniform formation. The Huronian and allied formations are the likely rocks; and these rocks, and these rocks only, should be featured as such. The remaining 90 per cent of the Pre-Cambrian, 1,800,000 square miles, or over half of all Canada, is made up of granites or granite gneisses and similar rocks. These granites have produced mica, corundum, and other minor minerals, but so far they have produced no major operation. The Sherritt Gordon was at first thought to be an exception, but agreement has since been reached that the containing rock is sedimentary gneiss and not granitic gneiss, so this deposit takes its place among rocks of the Huronian class and not of the granitic class.

In 1924 and 1925 I scouted throughout the Pre-Cambrian in the four central provinces. I discovered where prospecting work was being done and where the operating companies were spending money. The officials of some of these companies were receiving applause for work that featured the entire Pre-Cambrian as a mineral treasure-house; the papers were so handling the news and the publicity as to create and confirm the impression that every inch of the Pre-Cambrian was a source of great mineral wealth; and the Canadian public was putting millions into anything that was offered; but not one of the officials was spending a cent of company money in that granitic section that comprises nine-tenths of the Pre-Cambrian.

In Pre-Cambrian times great granitic intrusions forced the surface rocks of that period into mountain masses; and this original section of the world, then a mountainous country, has since been worn down almost to sea level. This granite basement is the prevailing formation, and the reason advanced for the

lack of mineralization is that erosion has been so great that all orebodies, except those in the Huronian remnants, have been worn away. Only roots of old deposits can be expected and, so far, none of importance has been found.

One of the arguments advanced by those who believe that there need be no worry in regard to future supplies of metals is that much ore will be found at depth. This view is expressed by H. Foster Bain in *Mining and Metallurgy,* October, 1926. In an article headed "Future Demand for Metals," he says: "If we knew the earth along a plane 5,000 ft. below as well as we know the present surface there can be no question that we would know many orebodies not now recognized."

Mr. Bain's conclusion with regard to the world in general is no doubt possible, at least; but in the Laurentian granite there exists a plane 1,800,000 square miles in area that can hardly be less than 5,000 ft. below a former surface, and may be much more, that appears to be almost barren. On the west coast of Canada is another similar intrusion, the Coast batholith—a mass of granodiorite extending the full length of this west coast and back into the interior for 100 miles. Taking the inside passage from Vancouver to Anyox, this batholith is around you on all sides, and a mile high. In it is no indication of valuable mineralization. The ore deposits, such as Britannia and Anyox, are in roof pendants—small remnants of sedimentaries similar to the Huronian areas of the Pre-Cambrian. The Dominion, therefore, is largely made up of or underlain by these granitic rocks, and this uniformly barren aspect hardly warrants the hope that exploration at still greater depth in such areas will be successful. Conditions elsewhere may be different, but for Canada the hope of appreciable mineral wealth in the granite at depth is a hope for which no justification now appears.

Canadian air force photographic view, showing an easily prospected area in the Pre-Cambrian

In considering statements in regard to Canadian mining reserves the procedure prevalent in the Dominion should be borne in mind. Canadian engineers endorse the rules governing the use of the terms "positive," "probable," and "possible" only when these terms refer to the reserves of the individual property. Applied to the Dominion as a whole they are considered to have a "deadening" effect; hence the claim for inconceivable wealth has been given to the public as a "fact," and is of importance for that reason.

In the belief that only what is popularly known as "optimistic" information should be published, vital facts have been suppressed; and the dissemination of false and misleading information is openly practised. Any statement is likely to get into print, regardless of its accuracy, if it is considered to be a "good advertisement" or will "boost" the country. A paper containing statements about the need for sticking to the facts and the folly of exaggeration is popular if the engineer presenting it is careful not to illustrate his remarks with any of the evidences about him. Articles, however, that question the claims to this inconceivable wealth are excluded from important reports and from the transactions of technical societies. An article of this type, referred to as "an attack on Canada's very vitals," is claimed to lessen the aggressiveness of the younger generation of engineers and to have an adverse effect on capital. One mining editor, although far from sympathetic with the inconceivable-wealth claim, believes that this propaganda is necessary, the inference being that otherwise "prospecting for minerals and mining investment would come very nearly to a standstill." The head of one large mining department characterizes this type of publicity as "the true spirit of the mining industry, without which the industry could not flourish as it does, but would languish." The men at the back of this campaign are not men who have axes to grind. They are engineers who have the best interests of their country at heart; and they are the men who have received the highest honors from their associates in mining work.

This type of campaign is not confined to Canadians. United States capital is heavily invested in Canada, where there are many American engineers. In fact, some of the large operations are staffed almost entirely by Americans. American engineers endorse this inconceivable-wealth campaign; and, if opposition is not to their liking, they do not hesitate to use their influence to suppress it. Their viewpoint was voiced By C. D. Kaeding, a prominent American in Canada, when he protested in these pages against the publication of my previous article on the Pre-Cambrian. Mr. Kaeding maintained that "The natural resources of a country were never developed by pessimists." On the other hand, the statement is made in the Hoffman paper: "There has been an overemphasis of the 'unlimited richness' of the Pre-Cambrian area, and that emphasis has had unhappy consequences." The censorship is so strict however, that rarely is a statement of this sort allowed to see the light in the Dominion.

What are the facts? What are some of the unhappy consequences of development based on unwarranted optimism? The late Sir Wilfrid Laurier, in bringing in his bill for the construction of

the Grand Trunk Pacific, stated that "It is established that the railway would place us in communication with the famous Omineca district, famous for its gold mines, which today are idle because it is impossible for the miner to get access to them with his tools and provisions, but which, probably, the moment we secure access to them will develop into another Klondike. It is established," said Sir Wilfrid also, "that the region between Winnipeg and Quebec is rich in all those resources that go to make a fine agricultural and industrial country." Both statements have been shown to be without economic or technical justification. The gold mines did not exist, on the scale mentioned, in the Omineca; and the optimists who have developed Canada have not produced one solitary mine in the 1,300 Pre-Cambrian miles between Winnipeg and Quebec. Railways constructed into the district went broke; so did the Canadian Northern, another product of undue optimism; and the Grand Trunk, interested with the government in the roads referred to. As Canadians had guaranteed their bonds, the roads were taken over to form the national system. Hundreds of miles of rail were taken up, and other hundreds of unproductive miles would be taken up were it not for political reasons. Canada's loss in these transactions is not less than a thousand million dollars, in addition to heavy losses sustained by the shareholders. Add to this the loss from the wasteful habits developed by persistent stories of colossal riches—the waste of timber, waste of soil, waste of soil fertility, waste of fish, waste of natural gas, and more vast sums must be subjoined to the total. Canada cannot afford to lose money at this rate. All this is the tribute paid to the rule of the self-styled optimist and his publicity technique and achievements.

The present stage of Canadian development corresponds to that period in the life of the prodigal son when he had more money than he knew what to do with, and he had his research organization seeking methods to deplete his capital at a faster rate. "Lots of men tell me," he doubtless said, "that one of these days my money will be exhausted, but so far the requisite supplies have never failed to turn up. Let us have more faith." Even during his most reckless spending period, corresponding to Canada's record production years, in which such pride is taken, the prodigal got much more for his silver than we get at the present time, the ratio in those days being 12 to 1 instead of 80 to 1, as at the present.

It is recorded, however, that the wealth of the prodigal became exhausted and "he came unto himself." There is some slight indication that Canadians may not wait until the arrival of exhaustion before facing the facts. The British Columbia government has taken a census of Douglas fir, and finds it good for only twenty years. It is therefore speeding up reforestation, and expresses the purpose to substitute hemlock and cedar wherever possible, and thus lessen the effects of the disaster. The *Financial Post,* the most widely circulated financial paper in Canada, in an editorial entitled "Does Optimism Make Us Prosperous?" concludes that the program of the optimist to extract sunshine out of cucumbers cannot be described as a success. It therefore purposes to report business and economic development without any attempt to gloss over unfavorable features. It audits the resources of Canada and points out some amazing shortages, regardless as to whether or not the article is considered good advertising for Canada. Its mining list, however, is handicapped by the fact that the official information features the Pre-Cambrian as a uniformly rich formation of 2,000,000 square miles; the Cordilleran as not one-fifth even prospected at all; and the coal estimate, as a real reserve, instead of an imposing array of figures, is over 95 per cent make-believe. It also overlooks the fact that Shakespeare is the great genius on whose methods some Canadian engineers base their work. The great dramatist was a famous doctor of plays; such engineers are doctors of statistics, and their masterpieces have only a foundation on fact. Even then the evidence is often indistinct.

Canada, in her wars with the Indians, with the Americans, and with the Germans, has a record for personal courage second to that of no country or age. There is no occasion, therefore, to fear the reaction of Canadians to an attempt to curb undue mining optimism. I have no hesitation in saying that if the people of Canada had, in the first place, been given the facts in regard to the limitations of their natural wealth, they would now be far better off in every respect.

Conditions will only get worse if Canadians refuse to face the facts. The idea that capital is influenced, that prospectors are influenced, and that the young mining engineer is influenced, and that this influence is favorable, by gross exaggeration of the possibilities of finding ore deposits is not only false, but it is poor psychology.

The first thing an engineer, representing outside capital, learns on coming to Canada is to steer clear of the granites. The money that has been taken from the Canadian public by misrepresentation has done the industry harm and not good. That the aggressiveness of the young engineer is increased by bringing him up on stories of inconceivable wealth is a strange statement to come from university trained men, with years of mining experience. Even an ordinarily intelligent young engineer soon learns the facts, and with that knowledge his opinion of mining publicity methods and those responsible for them is not enhanced.

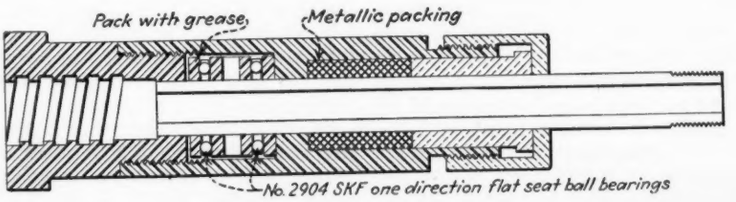
The term "Pre-Cambrian" has been worked overtime and should be given a rest. If reference to the geologically favorable areas be intended, they should be referred to as the "Huronian and allied rocks," or listed in detail. Opportunity exists for mining men to reserve the term "Huronian" for this favorable group, or to agree on some other suitable term. A false picture is certainly presented when "Pre-Cambrian" is used as a broad term to cover the district in which the geology is favorable for the development of commercial ore deposits.

The Huronian and allied rocks are entitled to every respect. They have produced the iron of Minnesota, the copper of Michigan, Ontario, Quebec, and Manitoba, the nickel of Sudbury, the silver of Cobalt, and the gold of Porcupine and Kirkland Lake. They comprise areas in Canada of about 200,000 square miles; and though, as has been pointed out, much of this section has been explored, considerable virgin ground is still left, and large areas justify more detailed prospecting. These areas are worthy of every attention.

■ ■

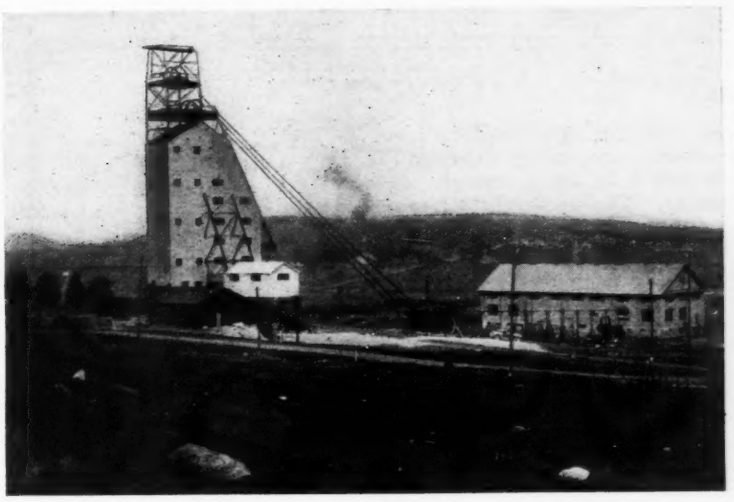
Water Swivel For Diamond Drills

A RELIABLE water swivel is important in diamond drilling, as it increases drilling speed and reduces the cost of such work, writes C. S. Watt, of Auburn, Ind. Unsatisfactory performance of the type of swivel commonly used led to the development of the water swivel shown in the accompanying illustration. This device is of a sturdy, simple construction, designed to insure continuous operation. Among the novel features are the strong water packing gland and two ball bearings to take up the thrust in either direction, thus avoiding the necessity of making annoying adjustments.



Shaft Sinking and Electrification at the Newport Mine

A. H. Hubbell
Associate Editor



Headframe and engine house at new shaft of Newport mine, Ironwood, Mich.

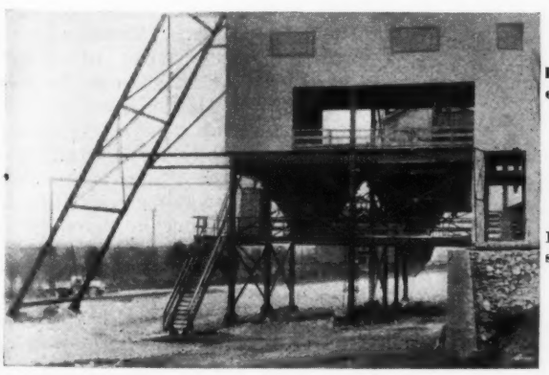
LONG an outstanding example of efficient steam operation, the Newport mine, at Ironwood, Mich., on the Gogebic Range, is at last yielding to the steady trend toward electrification that has been so evident in the Lake Superior Iron Country in the last decade. Six years ago, on visiting the property I found the management seemingly well satisfied with steam and proud of the excellent results obtained. Today the steam plant at the Woodbury shaft is about to be scrapped, as part of a plan to transfer the hoisting of all ore to a new shaft now being sunk some distance away, on the completion of which operations will be completely electrified.

The old plant had its advantages. Steam made in three 750-hp. Badenhausen water-tube boilers was used to drive the several hoists, the exhaust of which served to operate a 500-kw. mixed-pressure turbine and to supply the heating plant. With the turbine was generated power for the shops, the underground haulage, lighting, and pumping. Two Sturtevant fans, one motor-driven and the other turbine-driven, supplied the forced draft for the boilers, taking the air from the top of the power house instead of the cold outside air. All this is now to be scrapped. The new hoist and compressor house has a small heating plant, and, after the new shaft is finished, the shops, storehouse, and mine office will be constructed close to it. Power for the new plant will be purchased from the Lake Superior District Power Company, which will supply it at 33,000 volts, to be stepped down in a permanent substation to 2,300 volts.

The new shaft which is being sunk has not yet been named. When completed, it will be a duplicate of the present ore-hoisting shaft (Woodbury). The latter was started in slates but cut granite 600 ft. down. Now the slates moving on the granite are giving trouble. The new shaft is collared 300 ft. back of the granite-slate contact and will be in granite all the way down. It is 1,900 ft. horizontally from the Woodbury shaft.

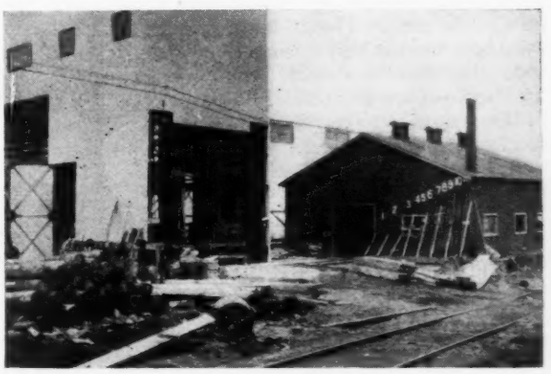
Sinking was started April 27, 1931, and the first cut pulled two days later. At the time of my recent visit (May 20) the shaft was down 135 ft. It is 13 by 21 ft. in the clear and will have six compartments to accommodate two cages, two skips, a pipe way and a ladder way. It is being timbered with steel sets made of 6-in. H sections on 8-ft. centers, the connecting angles being riveted and bolted in place. Dimensions of the skipway are 5 ft. 9½ in. x 6 ft. 0½ in.; cageway 5 ft. 9½ in. x 10 ft.; ladder way and pipe way, 5 ft. 9½ in. x 3 ft. 0½ in. each. See Fig. 1.

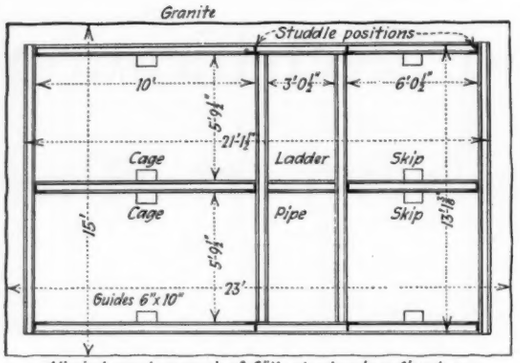
In the drilling practice followed and in the method employed for removing the broken rock the shaft work is most interesting. The round of 60 10-ft. holes employed includes a hole 4 in. in diameter, drilled with each round vertically in the center of the bottom, the purpose of which is to provide a free face for the surrounding holes to break to. Spacing of these holes is shown in the sketch in Fig. 6. The large hole is drilled with a heavy Gardner-Denver No. 17 drifter, a self-rotating hammer drill, and 1½-in. hollow-round steel having a 4¾-in. cross bit at the start and a 4-in. bit at the finish. Aside from this



Left, Rock pockets in shaft house

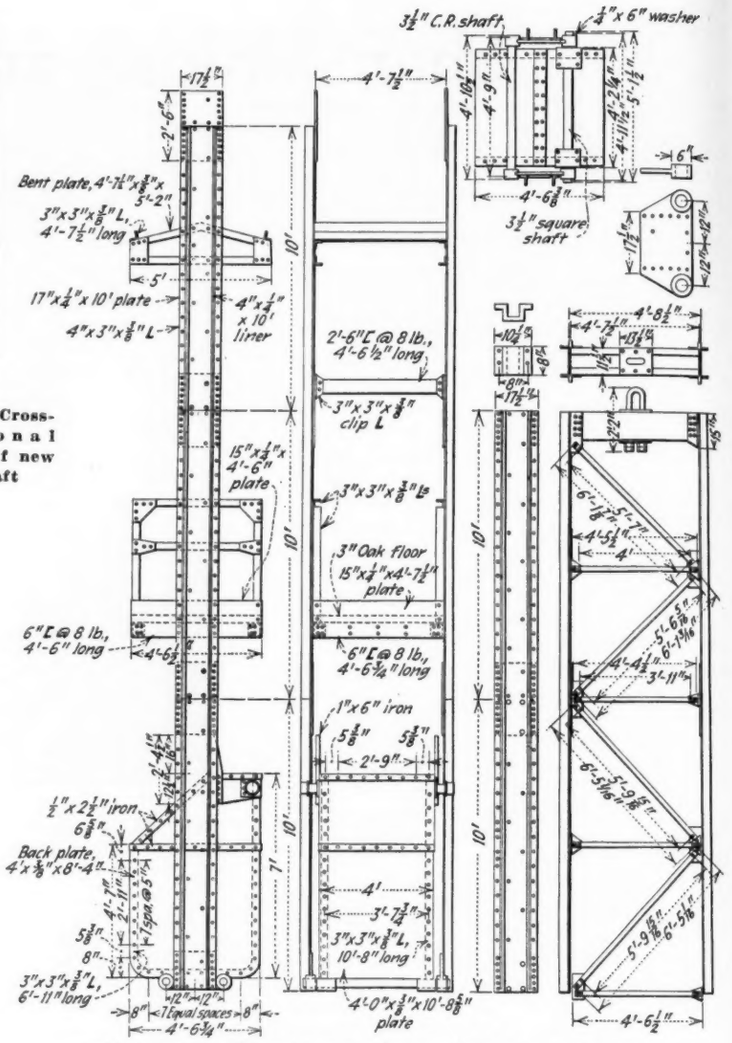
Right, Steel sharpening shop at shaft





All steel members made of 6"H sets placed on 8' centers

Fig. 1—Cross-sectional sketch of new shaft



All rivets to be ⅝" ϕ except in bail splices and joints, roller bracket and dumping horn. Countersink all rivets on inside of skip. 4" x ¼" x 10' liners in bail to be held in place with ⅝" ϕ countersunk rivets on about 12" centers. Ends of 10" x ¼" x 10' liners to be beveled. Entire skip to have ⅜" liner plates held in place with ⅝" countersunk head bolts.

Fig. 2—Skip specially designed for sinking work, now in service in new shaft of Newport mine

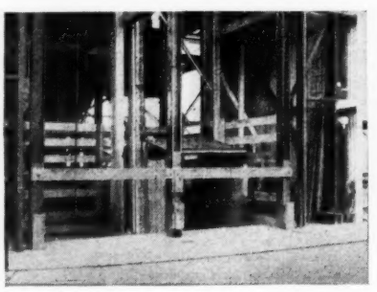
hole and the eight smaller holes immediately surrounding, shown in Fig. 1, the round is one commonly used in sinking. The smaller holes are drilled with I-R X59 sinkers and 1-in. hollow-hexagon steel. Order of firing is indicated by the numbers on the drawing in Fig. 6. The drilling is dry, there being sufficient running water in the shaft to keep down dust. The water is little on the whole and is baled into the skip. Ordinarily, water is not met in the granite.

The permanent air line in the shaft is of 8-in. flanged pipe. It extends to the last shaft set, about 30 ft. above the bottom. To get the air to the drills, two headers, each having nine air connections, are suspended flexibly from a 4x4x8-in. tee on the end of the line. One of the headers is shown in Fig. 5.

To one 4-in. end of the tee is attached an elbow and to the other a length of 4-in. pipe and an elbow to give a spread of about 4 ft., as shown in sketch. From each elbow hangs about 25 ft. of 3-in. air hose, terminating in two cast-iron elbows, reversed with respect to each other, the flanged joint between each pair being provided with a hook to permit hooking to a shaft set. Into the bottom end of the lower elbow of each pair is screwed a piece of 4-in. pipe, which terminates in the header mentioned previously. This has connections for nine drills (eighteen drills for the two). It is about 9 in. wide and 4 in. thick and is a casting bored in the center and radially from the cylindrical surface for the nine holes. Into each of the nine holes is screwed a nipple and a valve. The air hose for each drill is attached to this header, thus permitting short lengths of hose to be used. The 25-ft. lengths of 3-in. hose used in this arrangement provide the desired flexible connection. Twelve to fourteen drills are used on a drilling shift, so that there are extra connections for blowing.

In blasting, electric blasting caps and delay igniters are used. The shot is fired by a two-throw master switch in a room on the surface where the miners eat lunch. For this purpose the 250-volt lighting and power circuit is used. The numbers in Fig. 6 indicate the delays. The latter are made up and kept in a shed on the surface about 200 ft. from the shaft. Each delay is attached to its stick of power, and this stick goes near the bottom of the charge.

The center hole is not loaded, and it is drilled with each round and about 1 ft. deeper than the remaining holes.



Top of sinking cage in shaft. See Fig. 3

Rock from the first cut-holes blasted is thrown up the shaft to some extent, but the other holes break toward the free face and rock is not thrown upward. The blasting switch on the surface has two throws, one of which short-circuits the blasting circuit. The permanent wires are carried down the shaft to the last set, and, when not in use, are there short-circuited by being tied together with a loop of wire. Temporary blasting wires which are destroyed by the blast are run up from the charge at the last moment and attached to the ends of the permanent wires. When ready for blasting, the short-circuiting loop of wire is removed. To blast, the two-way master switch at the top is thrown from the short-circuit position to the firing position.

Powder used is 80 per cent gelatin in 1¼-in. sticks, generously tamped with clay. In some cases, a 10-ft. hole was loaded for a third of its length with

Drill header used in sinking. See Fig. 5

powder and was then filled to the collar with stemming. Tamping is insisted upon. The powder man makes sticks of stemming of the same size as the powder.

To muck out the bottom in minimum time after a blast, resort has been made to some ingenious devices. Hand shoveling is almost a lost art in the Iron Country, so extensively has mucking there been mechanized. Shoveling has naturally lost whatever popularity it may have had. On assembling a sinking crew, the men will most likely be found to have lost their quondam dexterity with the muckstick and their taste for it to be a minus quantity.

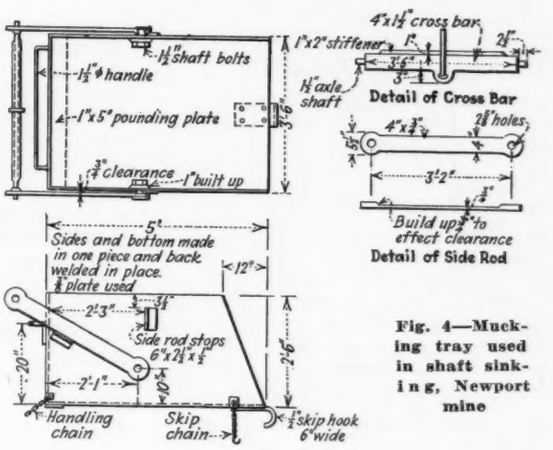
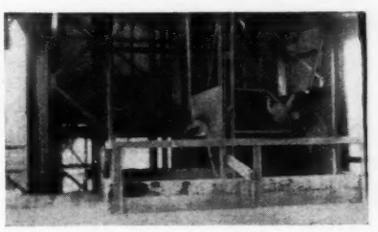


Fig. 4—Mucking tray used in shaft sinking, Newport mine

This consideration, as well as the natural instinct of the engineer to perform a given task with maximum efficiency, has led to the utilization of two not widely used interesting inventions, now to be described. One of these is a tray, shown in Fig. 4. The other is the sinking skip employed. Into the tray the broken rock is shoveled. The tray is 30 in. high, 5 ft. long, and 42 in. wide and is open on one side and on top. It is balanced with respect to its center of gravity so as to keep it from tipping prematurely on being lifted. It holds approximately 35 cu.ft. When loaded, it is hoisted sufficiently to dump it into the 4-ton sinking skip which sits directly on the shaft bottom. Hoisting is done by a 10-hp. single-drum air hoist mounted on the lowest shaft set.

To permit the skip to sit on the bottom, as stated, some 30 ft. below the shaft sets, it is attached to the end of a "harness" or "bridle" about 30 ft. long, the upper part of which remains on the guides above. To keep the skip from tipping out of the bridle, two arms are provided on the bridle, which engage with corresponding lugs on the body of the skip. Just before the latter reaches the dump at the top, the back end of the arm engages with a projection in the skipway, thereby raising the opposite end and releasing the skip so that it can dump. The shaft guides are of wood and 6x10 in. in section and surfaced on four sides.



Sinking skip in dump

Two cages, similarly mounted in a harness to permit them to reach the bottom, are provided for moving men, timber, drills, steel, and all other supplies. One is shown at the left.

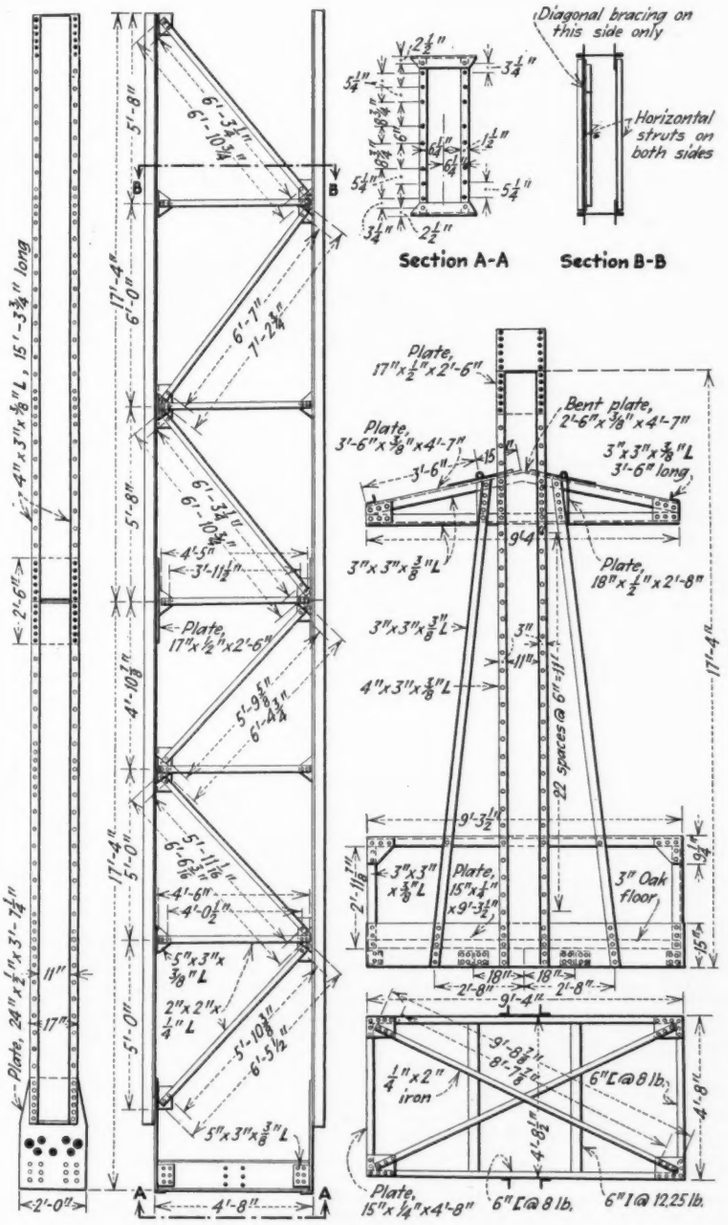


Fig. 3—Sinking cage at Newport mine

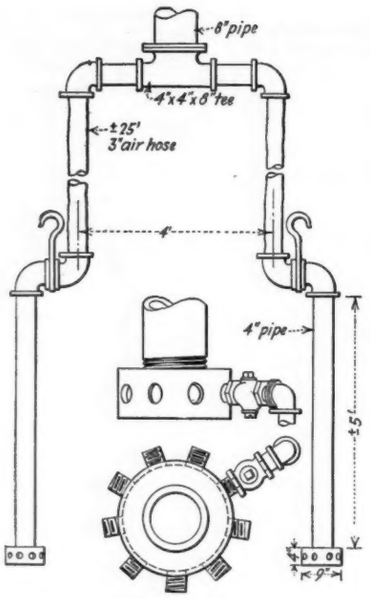


Fig. 5—Sketch of air-drill header with nine connections. See footnote.

Sinking is being carried on with a crew of thirteen men and a boss in the bottom. Work is progressing seven days a week on four 6-hr. shifts rather than three 8-hr. shifts, due to the desire to employ as many men as possible at a time when the iron industry is greatly depressed.

With the ingenious equipment described, the work of sinking is expected to proceed rapidly and smoothly. The length of the present cycle of operations will be materially shortened.

Ventilation is effected by means of a 10,000-ft. Coppus Vano blower connected to a 12-in. 18-gage steel pipe, which ends in a 75-ft. length of Ventube. The blower is driven by a 10-hp. motor.

The headframe at the new shaft is of the four-post type. It is of steel and about 135 ft. high. It is inclosed in corrugated galvanized-iron siding and is shown in an accompanying illustration. The hoist rope at present runs from the head sheave to a turn sheave on the ground at a distance of 180 ft. from the shaft, thence horizontally, or approximately so, 190 ft. to the engine room, thus avoiding the use of high idler stands. Stands will not be necessary when the shaft is in service. In designing the headframe, provision has been made for crushing the ore, probably to 3-in. size, because of more exacting furnace requirements. The crusher has not yet been selected.

Newport's hoist and compressor building is new and of fireproof construction throughout, having brick walls, concrete floor, steel roof trusses and purlins and a Pyrobar and asbestos-shingle roof. When the shaft is completed the hoist now handling the rock broken in sinking will serve as the permanent cage hoist. It is an Allis-Chalmers double-drum hoist, having drums of 10-ft. diameter and 6-ft. face. One drum is clutched and the other keyed. Drum shells are of steel plate with parallel grooves. Rope capacity is sufficient for 4,500 ft. of $1\frac{3}{8}$ in. rope in three layers. The hoist is driven by a 600-hp. induction motor through herringbone gears at 1,000 ft. per minute.

At the time of my visit the skip hoist to be used for hoisting ore had not yet been purchased, but it will be large, it is said, and will have a direct-connected motor. The hoist now used for moving the construction cages is a Nordberg double-drum hoist, having drums of 7-ft. diameter and 5-ft. face, one clutched and one keyed. This is driven by a 400-hp. induction motor and will have a capacity of 2,700 ft. of $1\frac{1}{4}$ in. rope. After the shaft is completed, it will be used as a cage hoist in the present Woodbury shaft.

The compressor installed in the new hoist house is an I-R 2-stage (with aftercooler) 3,600-ft. machine, driven by a 700-hp. synchronous motor. The building has sufficient room for an additional compressor. A motor-driven, 3,500-ft. I-R two-stage compressor now at the Woodbury shaft will be installed in it before the final change is made. This machine is driven by a 600-hp. synchronous motor.

In the new building the switchboard is of the Westinghouse cubicle type, having 2,300-volt oil switches and connections completely inclosed.

Steam-driven equipment now at the Woodbury shaft, and which the electrification of operations will render unnecessary, includes a 2,500-ft. cross-compound two-stage compressor; two 1,300-ft. cross-compound two-stage compressors; a 250-kw. cross-compound generating unit, making d.c. current at 250 volts; a 150-kw. tandem-compound generating unit, making d.c. current at 250 volts; a cage hoist with drums of 7 ft. diameter and 60-in. face and having 22-in. steam cylinders and 48-in. stroke; and a skip hoist, having cylinders of 34 in. diameter and a 72-in. stroke, with drums 12 ft. in diameter x 78-in. face. The skip hoist has been handling a 34-000-lb. load (on starting) consisting of 8 long tons of ore, an 8,000-lb. skip and 2,500 ft. of rope weighing over 3 lb. per foot. It accelerates from zero speed to 2,000 ft. per minute in 15 sec.

At another shaft, the Bonnie, as deep as the Woodbury, a steam-driven double-drum hoist with 24-in. cylinders and 48-in. stroke has been used. Drums are 8 ft. in diameter and 12 ft. face. This hoist has been handling skips holding $5\frac{1}{2}$ tons of ore at 1,500 ft. per minute. All pumping has been done through this shaft by means of a motor-driven Prescott duplex pump having a maximum capacity of 600 g.p.m. at 1,100-lb. head. Power for this unit has been purchased.

Hoisting ropes at new shaft pass around turn sheaves located on the ground

For standby service a cross-compound steam pump has been maintained in the Woodbury shaft at a depth of 2,150 ft., and for handling the water below this point a compound duplex steam-driven Prescott pump of 400 g.p.m. capacity. Also for standby service, a motor-driven plunger pump of 250 g.p.m. capacity has been maintained.

The Newport mine is owned by the Youngstown Sheet & Tube Company and operated for the latter by Pickands Mather & Company.

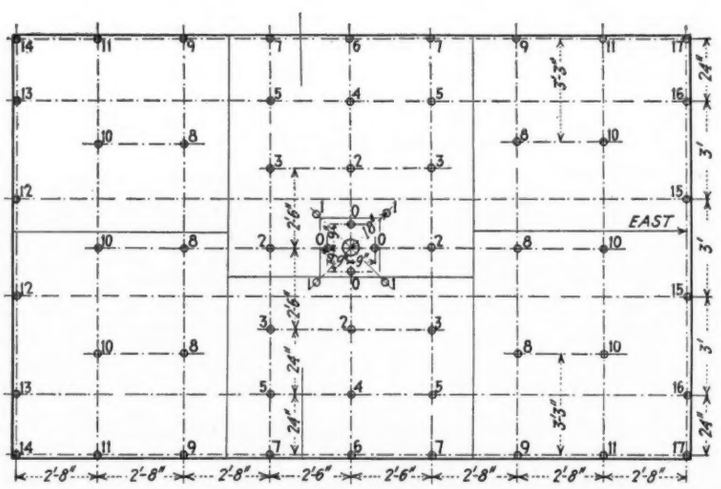


Fig. 6—Drill round, with center hole, used in sinking shaft

The tee is shown midway between the headers, differing slightly from the description on page 214.

Gold and Silver Recovery From Tin Slime

John B. Kasey

DEVELOPMENT of a method to recover gold and silver from tin slime was undertaken during my recent engagement in the research institute of the Non-Ferrous Metals and Gold Trust of the U.S.S.R., the Gintzvetmet. Underlying the method are the principles governing the selective affinity of the various metals for sulphur and oxygen, under suitable conditions and in the proper type of apparatus or furnace. This selective smelting of metals I have used to separate and concentrate copper from tin, lead, and antimony in a lead blast-furnace matte of high iron content.

The tin slime dealt with in this instance originated from the electrolysis of scrap brass and bronze, containing small amounts of silver and gold, in addition to larger amounts of lead, tin, zinc, nickel, antimony, iron oxides, and admixed sand. The wet slime, which originated in a solution of sulphuric acid, consisted of sulphates, basic sulphates, metallics, and free acid. Variations in composition of the scrap treated caused fluctuations in the composition of the slime produced, as illustrated by the accompanying analyses of the material in the bunkers where the slime was stored. Average content of water and sulphuric acid was 30 per cent. The analyses were made after roasting the slime at 650 deg. C.

Table I—Analyses of Tin Slime

	No. 1	No. 2
	Per Cent	
SnO_2	25.00	13.75
Sb_2O_3	5.26	13.25
PbO	36.00	26.87
CuO	8.13	14.20
NiO	4.45	5.00
ZnO	1.04	.98
SO_3	14.51	16.70
SiO_2	1.81	4.25
Fe_2O_3	2.70	5.00
Al_2O_3	0.46	
Total	99.36	100.00
Ag, grams per metric ton	7,713	9,163
Au	500.8	381

The purpose of roasting was to drive off free moisture and sulphuric acid, and some of the combined sulphur trioxide, to permit easier handling and greater convenience in analysis. Enough combined sulphur was retained to supply the amount required for producing a matte. This sulphur was mainly present as basic lead sulphate, as the roasting temperature was too low to break down lead sulphate.

The problem in treating the slime was to separate and recover four different metals and alloys: an alloy of gold and silver; pure copper; a white-metal alloy of tin, lead, and antimony; and nickel, or its salts. As the recovery of gold and silver was of primary importance, this phase of the problem, first attacked, will form the basis for this article.

In the concentration and recovery of precious metals in many industrial by-products and residues, copper matte usually serves as a collector, although lead may also be used. As in this particular operation the requirement was that lead be collected together with tin and antimony, to yield a white-metal alloy or babbitt base, the copper in the slime was used as a collector. An effective separation of copper from white metals was therefore necessary. To accomplish this, without bringing down too much of the white-metal content, the amount of coal used for reduction had to be determined within narrow limits. The basis for the calculation was therefore reduction of copper to the metallic state, and ferric oxide to ferrous oxide, expelling half of the sulphur as sulphur dioxide, the other half going into the matte. With finely divided, thoroughly mixed charges I have determined that about 10 per cent of the total carbon is consumed at red heat, by the reduction of carbon dioxide with carbon.

These theoretical calculations checked so well that the yield of matte could be closely controlled. The fluxes added to slag the oxides of nickel, zinc, iron, and aluminum consisted of ground limestone and silica, yielding a normal bisilicate of the type $(XO)(YO)2SiO_2$. This type of slag causes only negligible corrosion at the temperature employed, about 1,300 deg. C. With mixtures made to produce slags conforming to this formula, high-grade matte recoveries and clean separation of matte and slag were obtained.

In the first series of experimental runs on 1-lb. charges of slime, difficulty was experienced because the gas furnace used was not capable of developing enough heat to produce a slag sufficiently liquid to give a sharp separation of matte. When another furnace was used for the same mixture, however, the recoveries of gold, silver, and copper in the matte produced were 98.8 per cent, 95.3 per cent, and 99 per cent, respectively.

Matte yields were about 14 per cent higher than calculated, because some antimony, nickel, and a small amount of lead came down as speiss. This speiss, which usually separated well from the lighter matte, contained about the same amount of silver as the top layer of matte, but it carried sixteen times more gold. Antimony and nickel would, of course, be present in a minimum amount under the conditions obtaining in a reverberatory furnace—the proper furnace for selective smelting of this type—because the time element and the reacting surfaces would be greater than in a crucible, thereby permitting the reactions to proceed to completion.

With sufficient time for reaction between matte and slag surfaces, complete collection of the gold and silver in the matte is assured. Small amounts remaining in the slag as minute globules of matte, usually attached to small gas bubbles, may be collected; or, better, they may be prevented from forming by the use of a properly balanced charge. The gas bubbles consist of sulphur dioxide, from the reaction between sulphides in the matte and oxides in the slag. As the basicity—that is the quantity of free oxides—becomes higher, the dispersion of matte through the slag increases, as a result of the reaction between sulphides and free oxides.

When experiments were made to determine the least possible quantity of silicon to be added—no lime being used in these mixtures—the yields of matte were only about 40 to 50 per cent of the theoretical. Matte, in prills of various sizes, was dispersed throughout the slag, and separation of matte from slag was impossible. This condition may be remedied by using enough silica to combine with all free oxides. All other conditions being favorable, the slag will then contain a minimum amount of matte, and a sharp separation is possible.

Matte fall was always about 15 per cent, based on the original weight of the slime. Ratio of concentration of the gold and silver was from 1:5 to 1:6; copper concentration generally 1:6 to 1:7. Considering the complexity of the material treated, these ratios are high.

In some instances as much as 50 per cent of the antimony would form speiss and matte; a decrease in the amount of coal added, however, would reduce this figure to negligible proportions. Whenever large amounts of antimony went into the matte, much nickel would follow; otherwise, nickel remained in the slag, according to calculations. Only a small amount of lead—never more than 5 per cent—was

found in the matte. Tin and zinc were completely slagged.

Treatment of the high-grade matte presented no difficulties. The best procedure was to add it to a converter, with regular copper matte. In this way, matte of low precious-metal content would be enriched, and the dilution would prevent the loss that occurs when the high-grade matte is converted by itself. This was undoubtedly the most economical method of treating the matte to recover the precious metals, although, perhaps, not the quickest, on account of the time required in electrolyzing the blister copper to obtain the gold and silver as slime.

Two other methods for treating the slime were submitted by Russian engineers. The first of these involved briqueting the raw slime with fluxes, rich copper slags, and coal, using cement as a binder, charging the briquets to a blast furnace to volatilize the white metals, tin, lead, and antimony, the copper serving as collector for silver and gold. Large-scale tests were made with about 40 tons of slime, but the large amount of sulphur trioxide expelled during the initial stage of heating caused difficulties by destroying the woolen bags in the fume collector. To obviate this would necessitate the installation of a Cottrell treater, an expenditure not looked upon with favor at that time.

Another disadvantage of the method was that only 30 to 35 per cent of the white metals could be volatilized as fume. No mention was made about the recovery of nickel. The regulus of metal obtained from this blast furnace operation was treated further by blowing in a reverberatory furnace to slag off the remaining white metals and nickel. Fully 30 to 50 per cent of the copper content of the regulus charged was slagged in the effort to secure a satisfactory copper for electrolysis.

This reverberatory treatment resulted in a heavy slag fall; the slag, containing from 30 to 40 per cent metal, mostly copper, as oxides and prills, was returned to the blast furnace for remelting. Constant re-treatment of slag was expensive. The capacity of all furnaces was also reduced.

Claim was made that a high-grade babbitt base metal was obtained from the fumed white-metal oxides, but no analysis was presented. The white metal would undoubtedly contain sulphur, unless desulphurized with copper, in which case a scum of white-metal matte would be produced, which would have to be re-treated.

The second method proposed was a wet process for extracting copper, nickel, gold, and silver. Classification of the slime into coarse, medium, and fine was the first step of this method. The coarse material was melted directly to yield an impure metal that contained almost every metal present in the original slime. No suggestion was made for the further treatment of this product. Then the medium and fine grades were treated separately to dissolve all metallics, decanting the solution from the residue, which consisted of basic sulphates of lead, tin, and antimony, and the precious metals. The decanted solution and the wash water—containing mixed chlorides and sulphates of copper, nickel, and zinc, with small amounts of soluble lead, tin, and antimony—were passed over scrap iron to precipitate all metals but nickel and zinc. The cement copper was contaminated with white metals as well as with iron. Solution of the metallics was made by forcing air through the pulped slime in the presence of a solution of 10 per cent sulphuric acid and 3 per cent sodium chloride, and stirring the charge mechanically at about 90 deg. C. After this treatment the copper content of the residue was about 45 per cent.

After washing the residue free from acid, a 3 to 4 per cent cyanide solution was run into the vats to dissolve gold and silver. The high cyanide concentration was necessary on account of the large quantity of precious metals contained. Gold recovery was about 95 per cent; silver recovery generally about 60 per cent. Zinc was used to precipitate the precious metals from the cyanide solution.

The white-metal residue, consisting of basic and normal sulphates, was melted with soda ash, but the quality of babbitt-base metal was poor, unless desulphurized with copper. Metal losses in the soda-ash slag were high, as is generally the condition when this method is used.

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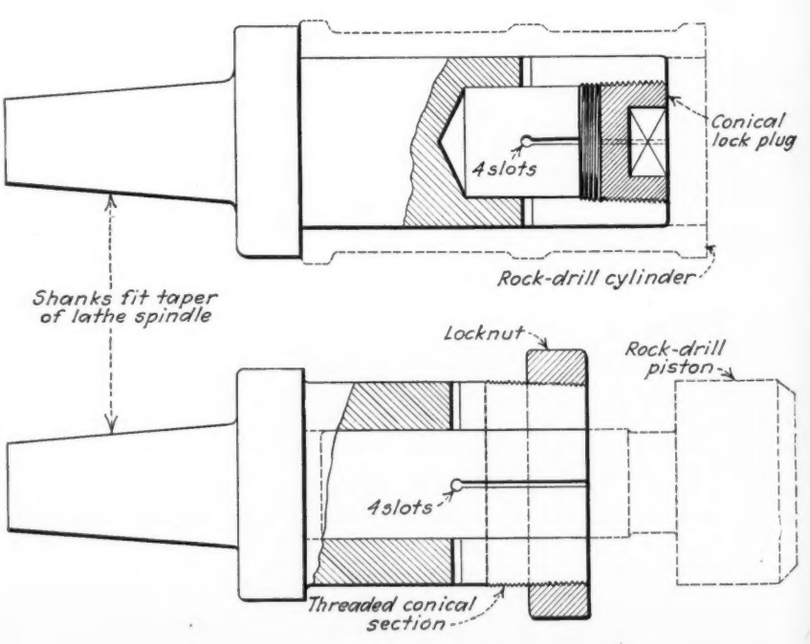
Repairing Drill Parts

INTELLIGENT repair methods and an adequate supply of good tools are important in effecting low repair costs. Home-made jigs and fixtures, particularly, are of value in this respect, because of the economies they provide in the manufacture of duplicate machine parts and the repair of worn parts formerly condemned to the scrap pile, owing to high repair costs. A set of special jigs for facing reground rock-drill cylinders and for rectifying drill pistons, developed and in almost daily use at the mine machine shop of the Moctezuma Copper Company, Pilares, Sonora, Mexico, is shown in the accompanying sketch. Novel features of these jigs include the slotted hollow arbor ends, over or into which the worn drill parts are first placed and then secured tight by the threaded tapered lock nut and plug; and means for attaching the tapered shank to the lathe spindle, thus avoiding wasting time in centering and adjusting of the drill parts that are otherwise necessary when employing a lathe chuck or face plate.



Canadian Nickel Smelter Boasts World's Largest Pulverized-Coal Plant

C. F. Herington

THE new Copper Cliff smelter of the International Nickel Company of Canada, Ltd., boasts the world's largest plant for pulverizing coal for use in metallurgical furnaces. This company, formerly known as the Canadian Copper Company, was one of the pioneers in the use of pulverized coal in reverberatory furnaces, its original installation dating back to 1912.

As originally installed, the coal plant consisted of two Ruggles-Coles rotary dryers and three 3½ to 4 tons per hour Raymond Brothers impact pulverizers. This coal plant served one reverberatory furnace, which consumed from 125 to 140 tons of coal per 24-hour day and was in operation when Heyl and Patterson, Inc., was given the contract for the new plant. This company was to design and furnish all of the equipment, including the coal building; to erect the apparatus; and to supervise the placing in successful operation of all of the machinery.

The new pulverized-coal plant was designed to serve five reverberatory furnaces, each furnace having a capacity of about 1,000 tons of concentrate per day. To furnish the requirements in two eight-hour shifts, the capacity of the pulverizing plant was made 54 tons per working hour.

Fig. 1 shows the location of the pulverized-coal plant in relation to the furnaces. It also shows how the coal is transported to the coal bins over each furnace, through 5-in. steel pipes by means of compressed air. If the reader will refer to the Nov. 10, 1930, issue of the *Engineering and Mining Journal*, page 461, he will find a drawing showing the relation of the coal plant to all of the buildings comprising the smelter. The flowsheet of the pulverized-coal plant is shown in Fig. 2.

During the summer the Nickel company purchases a year's supply of coal from West Virginia and Pennsylvania fields. This is slack coal containing 7 to 10 per cent ash, which is shipped by boat from Ashtabula, Ohio, to Little Current, Ontario, where it is unloaded on a dock and transported to the smelter as required.

From the coal bunkers at the smelter the coal is carried by belt conveyors to a Jeffrey hammer crusher, following which it is delivered by a belt conveyor to three 40-ton steel coal storage bins, each bin serving a rotary coal dryer in the coal plant. From these bins, the coal is conveyed to three 20-tons-per-hour single-shell rotary dryers, to remove the moisture from 8 per cent down to 1 per cent. These dryers are fired on the principle of parallel flow; that is, the hot gases enter the dryer shell at the same point as the wet coal. They are fired with pulverized coal, using short-flame burners of special design. See Fig. 3.

At the discharge end of the dryers is placed a recording thermocouple. An arrangement is made whereby if the temperature of the coal rises to 200 deg. F. the feed of the coal to the burner to that particular dryer is immediately shut off. At the same time an alarm is sounded so that the operator can cool the dryer by opening the doors in front of the combustion chamber.

The dryers are connected together by a common exhaust header which in turn is connected to a large exhaust fan having a capacity of 37,000 cu.ft. of air per minute. This delivers into a 12-ft.-diameter cyclone collector. The header is shown in Fig. 4. Coal dust arising from the collector is carried into a 36-in. pipe direct to one of the main flues from the reverberatories and thence into the large smelter stack. This dust loss amounts to 0.46 per cent of the amount of coal pulverized and consists

Fig. 1—General arrangement of furnaces and coal plant

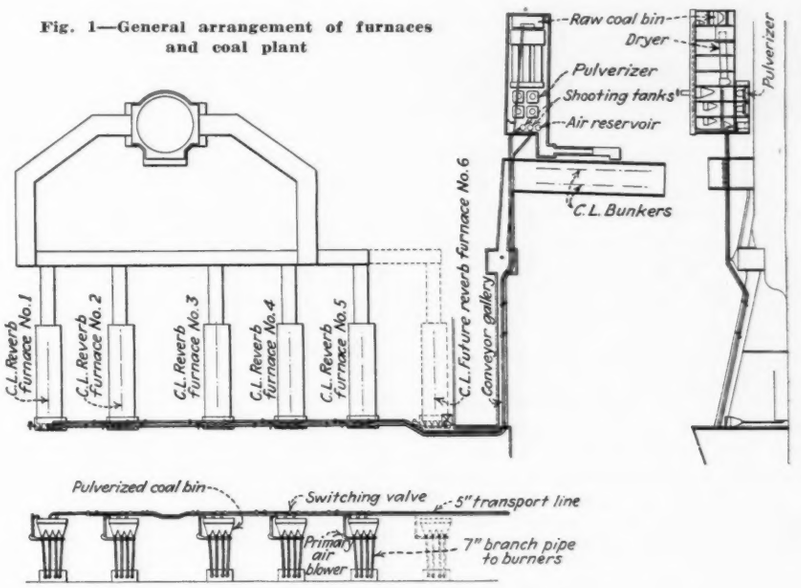
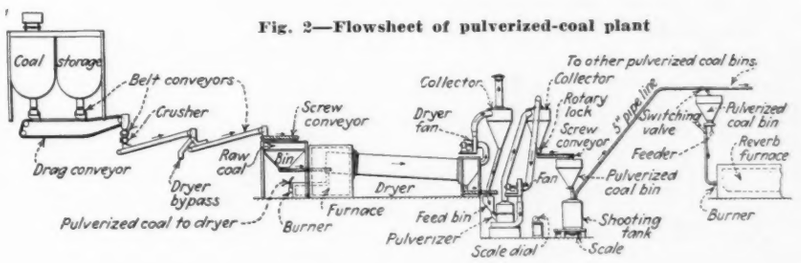


Fig. 2—Flowsheet of pulverized-coal plant



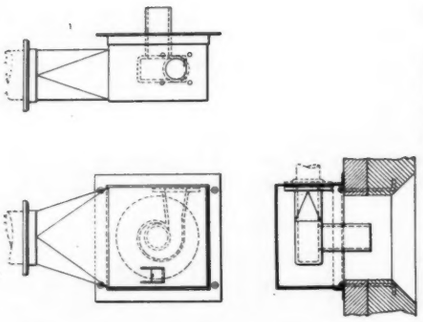


Fig. 3—Details of short-flame burner

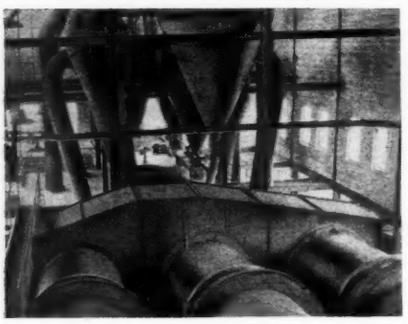


Fig. 4—Header and cyclone collectors

of particles that are finer than 300 mesh.

From the dryers the coal is delivered by screw conveyors into bins which feed directly into four Raymond Bros. impact pulverizers each having a capacity of 15 tons per hour. These pulverizers are connected so that the coal does not pass through the exhausters, but is drawn into the collectors and the air from the cyclone collectors is delivered back into the pulverizers. By this plan all wear on the exhausters is eliminated.

In Table I are given some of the results obtained in removing moisture with this kind of a dryer.

Table I—Moisture Elimination

Per Cent Moisture of Wet Coal on the Belt Conveyor	Per Cent Moisture of the Coal After Being Pulverized
7.0	1.5
5.8	1.7
5.6	2.0
5.1	2.5
5.6	2.0
6.0	1.0
7.3	2.5
7.0	3.0
7.3	2.0
5.8	1.5
5.5	1.5
7.3	2.0
5.95	2.0

From these collectors the pulverized coal, 95 per cent of which is ground to 100 mesh and 79 per cent through 200 mesh, is carried into a hopper by means of a screw conveyor. The hopper is installed over two large shooting tanks, which in turn are placed on Fairbanks scales for weighing. From the shooting tanks, the coal is delivered by compressed air in 5-in. pipes to any one of the five reverberatory furnaces, at distances from 500 to 1,200 ft. Two lines of pipe transport the coal to the 80-ton bins placed above each furnace.

The arrangement of the shooting tanks is shown in Fig. 5. In operating them, the bell valve is opened first, as is also the vent valve (not shown on the drawing), so as to allow the air in the tank to vent into a pipe and thence into the top of the coal bin. The bin gate valve is then opened, and the coal immediately falls into the shooting tank. Only about two minutes is required to fill the tank to 14,000 lb. Then the bin gate is closed, and afterward the bell valve and the vent are likewise closed. Everything is now closed tight and the tank is full of coal.

A valve is then opened which admits compressed air (and it must be perfectly dry air) from the air reservoir at 80-lb. pressure. This air travels down through the pipe shown by the dotted lines, striking the bottom of the tank at high velocity and turning back into the body of coal, fluffing the coal particles. This is continued until a pressure of about 60 lb. shows on the gage connected to the tank. The air is then shut off and another air valve opened from the same reservoir, which admits air to the top of the tank. This forces the coal-air mixture down to the bottom of the tank and out through the discharge pipe to the storage bin at each furnace. The progress of the coal leaving the tank can be watched by the movement of the dial on the scale as the coal leaves, and the rate at which the coal is transported is shown by Table II.

As soon as the scale shows that the coal is about out of the tank, the air is shut off, and when the dial is back to zero still another air valve line is opened and compressed air is admitted direct to the transport pipe for a moment. This has a tendency to clean out thoroughly the pipe line to the furnace.

A panel board in the room with the shooting tanks carries electric lights marked for each furnace. These lights are connected to the high- and low-bin indicators on the 80-ton bins at each furnace. When the red light is on, the operator at the coal plant knows that that particular bin is nearly empty; he accordingly shoots the coal over to it until a white light appears, showing

Table II—Logs of Shooting Tank

Time	Coal, Pounds	Tank Pressure, Pounds	Reservoir Pressure, Pounds
2.29½	14,000	..	90
2.30		Aerating	
2.31½	.....	80	88
2.32	10,800	70	..
2.32½	7,600	65	88
2.33	5,000	64	86
2.33½	2,500	60	..
2.33½	Air shut off	..	..
2.34	450	40	90
2.35	Tank empty and line blown out		
10.10	14,000	..	90
10.11½	Start	80	87
10.12	11,500	68	89
10.12½	8,500	64	89
10.13	6,100	60	89
10.13½	3,400	58	89
10.14	1,600	55	90
10.14½	250	25	88
10.15	Tank empty and line blown out		
2.01	12,000	..	82
2.02½	.....	79	79
2.02½	9,400	60	79
2.02½	7,800	59	78
2.03	6,200	58	78
2.03½	4,700	55	77
2.03½	3,200	54	76
2.03½	1,200	50	75
2.04	500	45	74
2.04½	100	38	..
2.04½	Tank empty and line blown out		
9.17½	10,000	..	80
9.18½	.....	76	76
9.19	7,500	58	75
9.19½	5,700	55	75
9.19½	4,400	54	74
9.19½	3,200	52	74
9.20	1,900	50	74
9.20½	1,200	47	74
9.20½	300	43	..
9.21	Tank empty and line blown out		

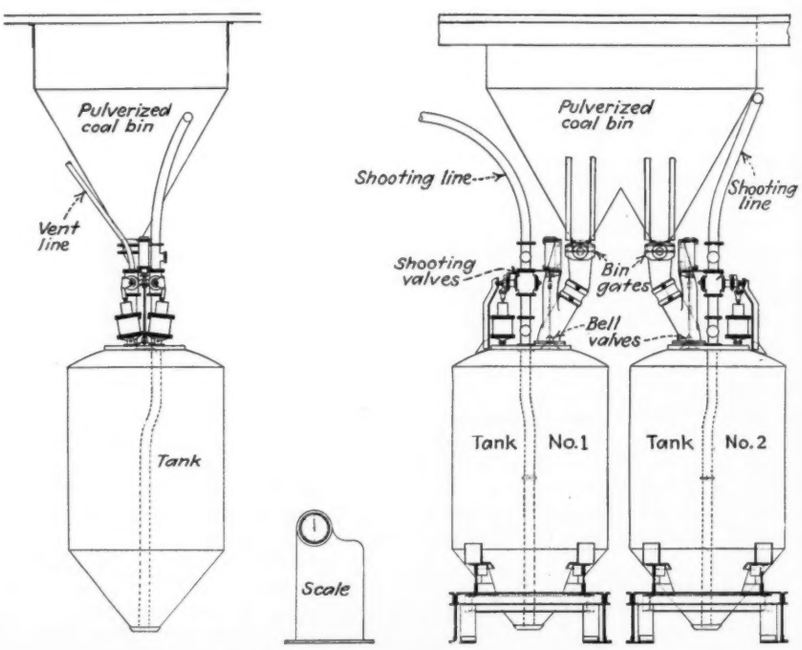


Fig. 5—Arrangement of shooting tanks

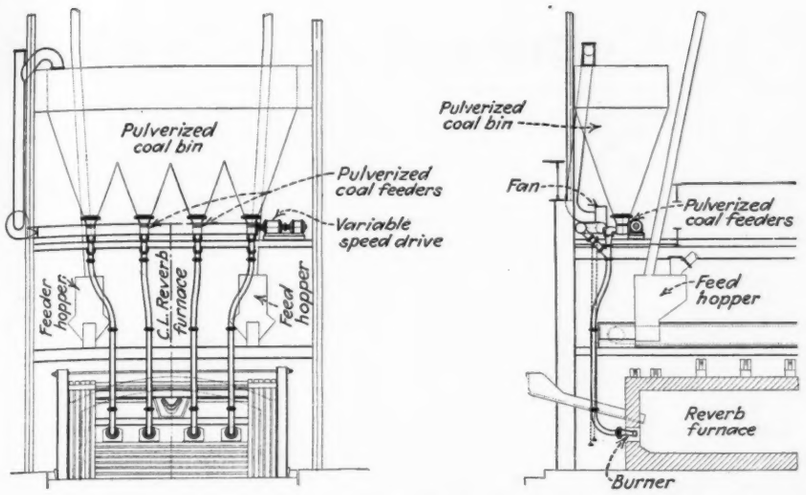
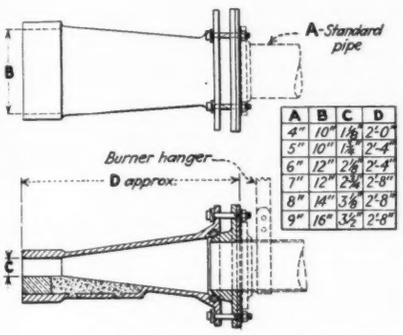


Fig. 6—General arrangement of pulverized coal application to reverberatory furnaces



A	B	C	D
4"	10"	1⅛"	2'-0"
5"	10"	1⅛"	2'-4"
6"	12"	2⅛"	2'-4"
7"	12"	2¾"	2'-8"
8"	14"	3⅛"	2'-8"
9"	16"	3½"	2'-8"

Fig. 7—Adjustable long-flame burner

that the bin is full. Under each furnace designation on the panel board is a switch button which enables the operator to open the transport valve in the pipe line so that the coal, when being transported through the pipe line, may be delivered to that particular furnace for which he opens the valve. A green light appears while this valve is opened.

At the bottom of each bin are four Heyl & Patterson double-screw feeders. Each group of four feeders is driven through a variable-speed reducer and a motor. The coal consumption can be varied from 700 to 3,500 lb. per hour. Each feeder consists of two steel screws cut from a solid-steel forging and is equipped with Timken bearings and a train of heat-treated bevel gears running in an oil-tight case. Each feeder is likewise equipped with a revolution counter, and each group of feeders is connected to a remote indicator in the superintendent's office, which shows at a glance the amount of coal currently being used by each furnace.

Fig. 6 shows the arrangement of the burners and feeders at each reverberatory furnace. Each furnace has four burners of cast-iron fishtail type, as shown in Fig. 7. Each burner has an opening 2¾x12 in., and is lined with concrete and firebrick.

Primary air is furnished these feeders by a secondary air blower, and is delivered by branch pipes to the burners, as shown by the drawing. Also, the top of the storage bin is connected to the suction side of this blower, so that when the coal is being transported to the bin from the coal plant by the shooting tank, the excess air is taken down this pipe into the blower and carried into the furnace.

The fuel ratios secured on one furnace for six consecutive weeks follow:

	Tons of Matte Plus Slag per Day	Ratio of Matte Plus Slag to Coal
First week	894	8.1
Second week	943	8.2
Third week	913	8.2
Fourth week	825	8.1
Fifth week	958	8.3
Sixth week	966	8.3
Average six weeks	916	8.2

The pulverized-coal plant was designed, installed, and placed in operation by Heyl & Patterson, Inc., of Pittsburgh, Pa., under my supervision and that of L. M. Sheridan, chief engineer of the International Nickel Company.

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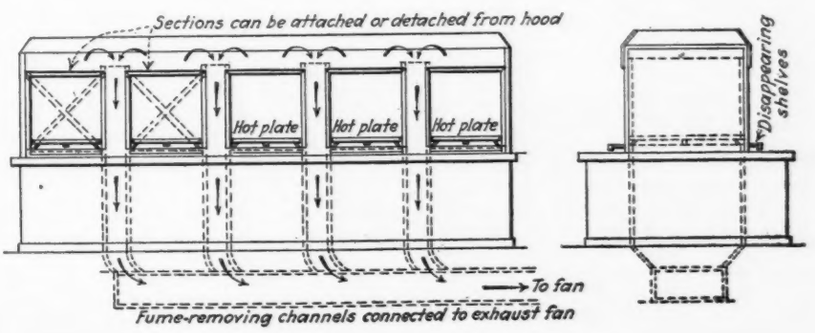
Laboratory Combination of Fume Hood and Hot-plate Table

OF particular interest at the research laboratory of the United Verde Copper Company, Clarkdale, Ariz., is the construction and installation of the fume hood and table combination shown in the accompanying sketch. The ventilation system consists of several downcast ducts, connected to the main channel and exhaust blower, which efficiently remove the fumes from the hot plates and those generated immediately outside the hood. Disappearing shelves, installed just below the hot plates, are useful to the operator and save table space. All hood wall sections, in the form of large removable rectangular blind flanges, can be bolted onto the front or back wall of each hood, thus enabling the operator to use one or more hoods, when required, the adjoining ones being used by a second or third operator from the opposite side without interfering with one another. With this combination, and because of its flexibility, considerable laboratory floor space can be saved and utilized for other purposes.



Personal Notes . . . Comment . . . Criticism

F. Benard, formerly superintendent of the Ontario Refining Company's plant at Copper Cliff, Ont., has been promoted to the position of plant manager.

C. C. Brayton, of the American Manganese Steel Company, Oakland, Calif., recently left for Alaska. He will visit Juneau, Fairbanks, and Nome.

Charles B. Whittier, head of the mining department of the Robert W. Hunt Company, of Chicago, was severely injured recently in an automobile accident while en route to Milwaukee. He was taken to the Wisconsin General Hospital on Aug. 10. His friends will be glad to hear that he is making a satisfactory recovery under the circumstances.

D. D. Irwin, general manager of Roan Antelope Copper Mines, Ltd., is taking his annual vacation. He was in London for a few days, before sailing for New York. Mr. Irwin says that the climate of Northern Rhodesia is delightful, similar to that of southern California.

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Among contributors to this issue:

Sydney H. Ball (University of Wisconsin) is a consulting engineer, with headquarters in New York, who is well known to our readers as an international authority and writer on the geology and mining of diamond deposits.

J. B. Kasey (Columbia) has had a wide experience in commercial chemical and assay laboratories. Early in 1930 he resigned as assistant chief chemist in the research laboratory of National Lead, at Brooklyn, New York, to accept the position of research metallurgist to the Gintsvetmet of the U.S.S.R. While at Moscow he developed the method of metal separation described in this issue.

K. L. Bockman is deputy professor of mining at the Norges Tekniske Hiskole, Institute for Grubedrift, Trondhjem, Norway.

Morris J. Elsing, who contributes the second of a series of articles on the cost of mining in the United States, is a consulting engineer with headquarters at Tucson, Arizona.

C. F. Herington is a specialist with a wide experience in the design, erection, and operation of plants using "Powdered Coal as Fuel"—the title of a treatise, published by Van Nostrand, of which he is the author.

C. M. Campbell, an alumnus of Manitoba and McGill universities, served, successively, as mine surveyor, superintendent, and resident manager of the copper and coal operations of Granby Consolidated at Phoenix, Grand Forks, and Cassidy, B. C. Association with American Metal, as mining engineer, took him to South Africa. In 1929 he returned to British Columbia, to become connected with W. R. Wilson & Sons, Vancouver.

Oscar Glaeser, safety engineer for United Verde, has been elected commander of the American Legion for district No. 8 of Arizona.

Robert E. Tally, vice-president of United Verde Copper, gave an address on the condition of the copper industry before the Phoenix Rotary Club on July 31.

V. M. Karmashov, whose article "The Gold Mining Industry in the U.S.S.R.," appeared in the Aug. 16th issue of *E.&M.J.*, calls attention to an error occurring in Table III of this article. Monthly wages for 1929 and 1930 were given as $87.00 and $52.50 respectively. These figures should be reversed, $52,50 for 1929 and $87.00 for 1930.

V. L. Eardley-Wilmot, specialist in non-metallics on the technical staff of the Mines Branch of the Dominion Department of Mines, Ottawa, recently made a tour of inspection through several properties in New York State, and visited New York City.

N. L. Wimmler has taken up residence in Tucson, Ariz., to attend a special course at the University of Arizona in executive training for accredited graduate mining or metallurgical engineers, under the supervision of **Dr. E. P. Mathewson.**

Charles L. Sinclair is taking a vacation at his home in Bisbee, Ariz., after having spent three years in Africa, where he was employed at Roan Antelope.

Harry A. Clark, general manager of Calumet & Arizona, at Warren, Ariz., has been appointed a member of the Arizona fish and game commission.

Fred Elliot, who worked the Aguilareña mine, at Santiago Papasquiaro, Durango, Mexico, from 1903 to 1905, or anyone who knows Mr. Elliot's present address, is requested to communicate that information to Dr. J. A. King, at Santiago Papasquiaro.

Lucien Eaton, recently in England, expects to be in New York in the latter part of September.

E. W. Hopkins, manager of Oglebay, Norton & Company's mines on the Gogebic range, with headquarters at Ironwood, Mich., is reported to have retired from active service.

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Common Sense, Plus Experience, Superior to Technical Training

To the Editor of "E.&M.W.":

Most mining engineers will, I think, have read with interest an article in your June issue entitled "Training the Mining Engineer to Direct and Control." The article deals with a question that concerns all those in the mining profession, from the president or chairman of an operating concern down to the youngest member of a training college for mining engineers. The article also raises some controversial points, which I trust have not been allowed to pass unchallenged, but on the chance that they have not been dealt with by worthier pens than mine, I venture to put forward other aspects of the situation, which appear to have escaped the author's notice.

The author states that:

"Education should develop toward a known end, whereby a mental attitude may be encouraged and knowledge imparted that will be of maximum value to the individual in his future field of employment." A most desirable development, and if the governing body of every mining college would model its syllabus on these lines, there would, I think, be much larger dividends available to the shareholders of mining concerns.

It is very truly stated that the manager of a mine requires only such technical knowledge as will give him a grasp of basic scientific and engineering principles. The multifarious knowledge that is required of a mine manager is perhaps not always fully realized, but it is difficult to mention any trade or profession which, at some time in his career, the mine manager is not called upon to exercise in a greater or lesser degree. He must of necessity therefore be jack of all trades and master of none, and the greater the size of the concern that he controls the less his technical knowledge would appear to be required.

The primary function of a mine manager is, as your contributor states, management or administration, with the ability to coordinate his staff, labor, and plant to the attainment of the best possible results.

Your contributor suggests that the power of administration or management can be learnt more quickly in a technical college than by the circuitous route of experience. I do not think that many will subscribe to this belief. The administrator is born, not made, and no amount of college training will supply that which is lacking, whereas experience only can give that *savoir faire* or faculty of knowing what to do that marks the good manager.

I shudder also to think of the reception that awaits future mining students who go to their first appointments provided in college with 60 per cent of administrative training and 40 per cent of technical training.

Most students in their heart of hearts (I speak from personal experience) believe that they go out into the world as full-fledged mining engineers. This subject was discussed recently in a British mining journal, where the results obtained from the best technical training were criticized by an eminent mining engineer, with special reference to the superiority complex of the average student. The academic head, who presided over this training, replied with a

spirited defence which delighted in the superiority complex under criticism. Members of mining camps throughout the world do not, however, I think, welcome the superiority complex of a newly joined student, and it is in fact this very complex that does immense harm to the student in the first years of his professional life. I trust, therefore, that no change of training will be made that will still further encourage the belief of the student that he is equipped and capable to step into a managerial post. Rather should the student leave his college with the idea that some ten years of experience lie betwen him and this senior post.

Many will agree that technical training is overdone, but rather than replace 60 per cent of technical training by administrative courses, I think the true solution is more attention to the development of what is known as common sense. The young receptive mind of the student should be trained in the powers of observation, reasoning, and deduction, as opposed to parrot-like memorizing of formulas and theories. A textbook is always available for reference, and the power of common sense will solve many problems not given in textbooks.

All knowledge at present available to man is surely the result of common sense applied by some member of the human race to a greater degree than normal, and the application of common sense has evolved from first principles the most complicated formulas, theories, and inventions. I would therefore strongly advocate the development of common sense both by personal effort and training. The possession of common sense, combined with the necessary experience, will soon give that *savoir faire* or administrative ability that leads to the appointment of manager.

Concentration on the development of common sense will also be toward that known end "whereby a mental attitude is encouraged and knowledge is imparted that will be of maximum value to the individual in his future field of employment," whatsoever that employment may chance to be.

R. B. Woakes.
The Indian Copper Corporation, Ltd., Ghatsila, P. O., District Singhbhum-Chota Nagpur, India.

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Obituary

Courtenay DeKalb, former associate editor of *Mining and Scientific Press,* died at his home in Tucson, Ariz., on Sept. 2. He was 69 years old and a native of Virginia. Details of his life will appear in an early issue.

Charles W. Badgley, mining and metallurgical engineer, died suddenly at his home in Herculaneum, Mo., on July 15. At the time of his death he was assistant superintendent of the smelting division of St. Joseph Lead, having come to Herculaneum in that capacity in October, 1923. Prior to that time he had held posts with American Smelting & Refining and Cia. de Minera de Peñoles. Mr. Badgley, who was 46 years of age, was a graduate of the Colorado School of Mines, Class of 1906.

Francis D. Weeks, well-known old-time silver-lead smelter, died at Canandaigua, N. Y., July 30, 1931, after having been about fifteen years in retirement. He was born at Renfield, N. Y., May 30, 1861, and graduated from the University of Michigan in 1882. During 25 years he was engaged in silver-lead smelting in Colorado and elsewhere. About 1907 he entered into charge of the works of Ohio and Colorado Smelting, at Salida, Colo. That company was a subsidiary of American Metal with which Mr. Weeks continued to be associated until about 1917, when he retired because of ill health.

Francis M. Smith, known as "Borax" Smith, mine operator, died at his home in Oakland, Calif., on Aug. 27, as a result of injuries suffered in a recent fall. He was 85 years of age. Forty years ago Mr. Smith was a prospector. While exploring in Death Valley, in California, he discovered a large deposit of borax of a high degree of purity. He accumulated a great fortune from the operation and subsequent sale of this deposit, but lost most of it thereafter in other ventures. At the age of 75 he again made a large fortune in another borax venture, this time near the Grand Canyon. By the time of his death, however, this fortune also had dwindled considerably.

George C. Mackenzie, secretary-treasurer of the Canadian Institute of Mining and Metallurgy, died suddenly on Aug. 22, while on a holiday at Bark Lake, Quebec, in the Laurentian Mountains. He was born at Kincardine, Bruce County, Ontario, in 1877, graduated in arts from Trinity, Toronto, and obtained his degree in mining engineering from Queen's University in 1905. After a few years' experience in the iron-mining industry in Nova Scotia, he was appointed in 1908 to the staff of the mining branch, Department of Mines, at Ottawa. From 1915 to 1918 he was secretary of the Munitions Resources Board of Canada. After another short interlude of commercial experience, Mr. Mackenzie was appointed to his post with the Institute in 1921.

In Appreciation

Joseph T. Tower, Jr., mining geologist, was accidentally drowned in the Rio Grande River, Texas, on Aug. 23, 1931. Mr. Tower, the son of Mrs. Maria B. Tower and the late Joseph T. Tower, of Millbrook, N. Y., was born on June 2, 1897, and was a member of the class of 1921 of Harvard. He was the fourth generation of a famous iron-mining family. His great-grandfather, Jonas Tower, who died in 1864, operated iron mines and furnaces at Crown Point, N. Y., and Ironton, Wis. Other areas which the family developed included the Port Henry iron mine, at Mineville, N. Y., smaller properties near Poughkeepsie, and the Vermilion Range, in Wisconsin. Joseph, Jr., carried on the family tradition in the reorganization of the Port Henry mine, a few years ago, but he early felt that the age of iron pioneering was over and turned his attention to the other metals. Possessed of ample private means, he chose the life of a mining pioneer in preference to the social ease and glamor of city life. In collaboration with his partner, Lanfear B. Norrie, he carried on successful exploration in the Rouyn and Sherritt-Gordon mining camps, in Canada. Recently he perfected the concentration of cyanite, in North Carolina. He also was successful in a gas venture in Virginia and in oil development in Oklahoma. The mining profession could ill afford to lose one of its very few real pioneers so early in his career. To those of us who were associated with him, the loss of a loyal and inspiring comrade will become more keenly felt each passing year.

Robert D. Hoffman.
New York City.

The following appreciation of George A. Chapman has been received from several of his personal friends on the Minerals Separation staff:

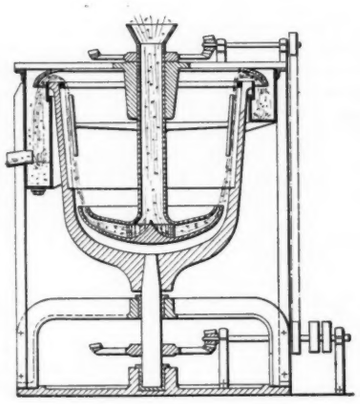
George Albert Chapman, whose death took place in New York on Aug. 15, was one of the outstanding figures connected with the development of the flotation process. Mr. Chapman was born in London in 1881. He was an honor student of Battersea Polytechnic Institute, London, where he took a five-year course in chemistry, physics, metallurgy, and engineering. In 1899, he started his professional career as chemist and assayer with Sulman & Picard, of London. While with them he was engaged in testing new processes for the concentration of ores, particularly those involving the use of oil. In 1904, he joined the staff of Minerals Separation Limited, of London, and went to Broken Hill, Australia, to demonstrate the Cattermole granulation process. While there, the news of the discovery in London of froth flotation was cabled to him, and he thereupon changed over the Cattermole plant to a froth flotation plant, this being the first working-scale plant to use the froth-flotation process. The commercial success of this plant was chiefly due to his ability and untiring energy.

Following this, Mr. Chapman had the principal part in the commercial development of the process and installation of flotation plants in various parts of the world. His duties took him to many European countries and to North and South America; and his practical knowledge, quick appreciation of local conditions, and his initiative, were factors in the rapid adoption of the process. Perhaps the most useful of his improvements in the process is the addition of the oiling agents to the mill during the crushing operation, an improvement which has become universal practice. He came to the United States in 1912 for Minerals Separation Limited, and later joined the staff of the predecessor of Minerals Separation North American Corporation, of which latter he became assistant chief engineer. During the War, he was consultant to the Canadian Imperial Munitions Board. In addition to brilliant technical ability, George Chapman was distinguished by his social gifts. In England in earlier years he was a keen cricketer and an active member of the Volunteer Force. Generous, a *bon viveur,* a good *raconteur,* a sportsman, and a staunch and loyal friend, he was welcome in every camp into which his work took him. "George," as he was widely and affectionately known, will be missed and deeply regretted by many beyond his own immediate circle. In 1905 he married, in England, Miss Edith A. Colwell, who, with a grown daughter and son, survives him.

INDUSTRIAL PROGRESS

Amalgamating Gold Ores and Sands With Aid of Centrifugal Force

A MACHINE that utilizes centrifugal force, successfully it is said, in amalgamating free gold ores, placer sands, concentrates from sluice boxes, and so-called black or magnetite sands, has been developed by Gold Savers Limited, 311 Dominion Bank Building, Vancouver, B. C. The machine, which is patented, is called the Lorentsen centrifugal fine-gold recovery machine. According to the company, it is made in various sizes, is ruggedly built, and can be easily handled. The size with which the company has had the most field experience handles 1 cu.yd. of concentrate (averaging 4,300 lb.) per hour, and requires a little less than 2 hp. to operate, the friction being slight owing to the use of ball bearings.



Centrifugal force is utilized in this amalgamating machine.

Essentially, the device consists of a bowl mounted in a casing, and rotatable at any desired speed. To operate it, mercury is placed in the bottom of the bowl, which is then rotated until the mercury spreads out over the inside through the action of centrifugal force. The sands or other materials to be treated are then introduced with water into the feed pipe of a centrifugal pump, which is specially arranged so as to deliver the pulp from the bottom of the bowl in such a manner that its angular velocity exceeds that of the bowl. This facilitates its distribution evenly on the surface of the quicksilver. Attached to the feed pipe are four arms that revolve with the pump and at equal speed. To these, in turn, are attached flexible devices which, as the machine revolves, throw out blades which travel parallel to the mercury wall and close to it, thus serving to agitate the materials as they travel upward toward the edge of the bowl.

Under the action of the centrifugal force, the component parts of the sands treated tend to separate, the heavier particles moving to the outside, where they penetrate the mercury and are held against the wall of the bowl. Clean gold is quickly amalgamated and dusty or greasy gold (and platinum) is retained against the wall until the rotation ceases. The sand or other material, of lesser specific gravity than that of mercury, passes over the surface and out over the edge of the bowl. When the machine is brought to rest, the quicksilver is scooped out, strained and retorted in the customary manner. A machine, such as this, capable of handling 1 cu.yd. of concentrate or 2 to 3 tons of milling ore per hour, will require about 50 gal. of water per minute, which will also suffice for removing the tailing. If water is scarce, some method for circulating it can readily be devised.

According to the company, the machine has been tried out under exacting conditions on beach-sand concentrate of Graham Island in the Queen Charlotte Group, British Columbia. Difficulties were great, the camp being two days away from any source of supply. The machine used (1 cu.yd. of sand per hour) has handled approximately 1,000 cu.yd. of concentrate and has made continuous runs, it is said, under critical examination. In a month's trial it made a recovery of 93 per cent, and since then has done substantially better, owing to improvements made. R. G. Mellin is quoted as reporting that out of twelve samples of tailings taken and assayed, the returns from one gave a trace of gold and the remaining eleven showed none. On treating sand around Martell Creek an average recovery of $2.11 per cubic yard in gold was made out of a total of $2.25 per yard.

Loss of quicksilver was practically nil native quicksilver being said to be recovered in the course of operation. In experiments on a smaller scale, the company says it has handled almost every kind of crushed ore containing free gold, including talcy ores. The machine has been found to do exceptionally good work in amalgamating gold from sixteen mesh and under.

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Improved Lubrication Practice Gets Results in Tri-State District

CORRECT LUBRICATION has been an important factor in decreasing waste in the mining industry of the Tri-State District, writes John C. Dittbrenner, of the Vacuum Oil Company. In this district, all kinds of power are used: diesel engines, gas engines, reciprocating steam engines and turbines, and electric motors in large numbers; also air compressors and hoists. Each of these sources of power presents a separate problem. So far as concentrators are concerned, the problem is one of bearings.

Some operators have always paid a great deal of attention to lubrication, realizing its benefits. Others have assumed that applying oil to a bearing in copious quantities was all that could be done, and, if the bearing remained cool, or partly so, the lubrication was considered to be efficient. Correct lubrication, however, takes into account the design, construction, and operation of machinery. If the problem is principally one of bearings, it is somewhat simplified. But bearings are of many types, each requiring specific treatment and accurate knowledge of the factors involved. Here again the problem in the Tri-State district is simplified, as the bearings are primarily all of the plain babbitt type. Some are ring-oiled, some

collar-oiled, some hand-oiled or waste packed; all are different. functioning under different conditions of speeds, loads of different sizes, mounted in different ways—some in clean places, some in excessively dirty places, some operating in water, such as elevator pit bearings. In fact, in solving the problems in any one mill many different factors had to be taken into account, and in some instances all of the factors involved in bearing lubrication.

Lubrication is no longer regarded as a means of merely decreasing metallic friction. It has long been known that the working parts of a machine may be completely separated by a thin film of oil which takes within itself all the forces on the bearing and prevents the wear of parts by keeping them from touching. This oil film constitutes the nucleus of correct lubrication, and the creation of this film within a bearing is the problem of the lubrication engineer.

Plant operators sometimes declare that they have no lubrication troubles. Granting this, one may say that a marked difference exists between "no troubles" and perfect operation. Best results can be secured only by careful analysis of conditions and grouping and comparing operating requirements, thus leading to the use of lubricants correctly selected to give maximum service.

In judging the value of lubricating oils, one should bear in mind that oils are used to reduce friction and wear; that correctly selected oils will do this effectively and economically. Careful analysis is necessary for selecting the correct oil for each type of bearing and to meet the needs under each set of operating conditions. Thus, lubrication has become a science, based on research, study of natural laws, and verified by practical experience.

For the purpose of this article, the reader is requested to consider a hypothetical mill, handling 45 tons of ore an hour, and consuming in this work 450 hp., not counting that used for hoisting. The power required to turn these machines without load will be approximately 75 hp. This amount is used in overcoming friction and the other 375 hp. in doing useful work, to crush ore and produce concentrate. Those responsible for operations are not concerned with the 375 hp., but are vitally concerned with the 75 hp. used in overcoming friction. If, by a study of all the factors involved in the operation of this mill, the correct appliances and oil can be found that will produce a film strong enough and tenacious enough to cling to the bearing surface, to cling to the journal and to take within itself all the force and the pressure being brought upon it, to localize the friction within the film of oil, this frictional horsepower can be decreased 10 to 30 per cent. This saves power. Taking the smaller figure, 10 per cent, the saving will be 7½ hp., and, in many cases, this is sufficient to pay for the oil involved in correct lubrication. This materially reduces the total cost of maintenance and replacements.

Not uncommonly bearings are found to be running on the ragged edge of safety, which require periodic replacement. Operators long thought that this was a penalty they must pay for operating machinery. This is not true; and in many cases, when the bearing has been analyzed properly, lined up and grooved correctly, the proper appliance employed and the correct oil used so that an oil wedge might be established and maintained, bearing failures have ceased and maintenance has decreased, with a corresponding increase in the saving of power, labor and material, and an increase in profits. An illustration of this was a flotation plant in the Tri-State district. Prior to installing correct lubrication, horsepower was measured and carefully noted. After lubrication was corrected and production maintained, the power consumed was found to have fallen off 16⅔ hp., and oil cost to have decreased 60 per cent even though the oil in service cost more per gallon. Such data are not exceptional, but are to be found whereever correct lubrication practices and methods are employed.

Correction of conditions, however, is not the work of an inexperienced man, but rather requires the accumulated expert knowledge of a company long experienced in the work. In an earlier issue, a description of the Bird Dog mill, the district's new centralized milling plant was given. It was my good fortune to be permitted to audit this plant and install the lubricants and appliances required. In the article, the Bird Dog was said to be an example of lubrication efficiency. This is true. Lower lubrication costs now prevail. power consumption is nominal, bearing failures are unknown, and operations are continuous. To show how small things may affect the operation of machinery, let me illustrate. A certain new machine was giving trouble. Upon starting, it would not run idle without heating, and not much could be expected of it in the way of work. At once the oil was blamed. Upon being called on to justify my recommendations, I analyzed the existing conditions and found that, by running the machine backward or by reversing rotation, an oil film was established. Six weeks later, the machine was dismantled, new bearings, made out of more suitable metal and properly grooved to assist in forming an oil wedge, were installed, and, to this day (over ten months later), this machine is still operating satisfactorily.

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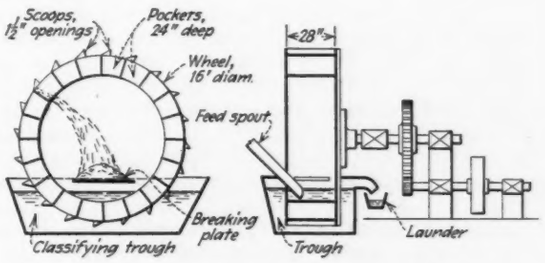
New Machine Classifies and Breaks by Impact

Other Late Equipment

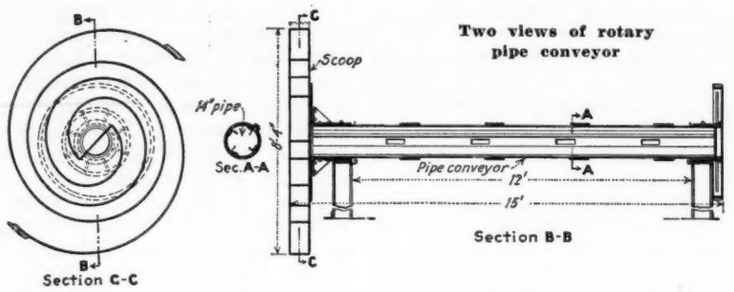
AN impact "mill" for fine-reduction has been constructed and placed in operation by A. D. Hadsel at the property of the Monarch Development Company, Ltd., near Auburn, Calif. The mill has attracted considerable attention by reason of the fact that it combines rock breaking and fine reduction as well as classification in a single unit. A. D. Hadsel, a mechanical engineer, invented the mill and is now operating it upon a low-grade gold deposit.

A dragline bucket is being used to deliver the ore to the milling plant. The "mill" is an overhung wheel similar in principle to the tailings wheel. The diameter is 16 ft.; the pockets are 24 in. deep by 28 in. long. On the periphery of the wheel are scoops for returning oversize material to the pockets. The wheel is revolved at the rate of 2 r.p.m. Power source is a 20-hp. gasoline engine. It is estimated that the engine delivers approximately 17 hp.

In operation, the run-of-mine ore is delivered to a feed spout which discharges into the pockets of the elevator wheel at their lowest position. Each pocket discharges as it rises, and the mass of ore falls upon a breaking plate constructed of rails. The spill falls into the trough and finally into the pockets, finished material in part being suspended in the pulp that fills the trough, as shown in the accompanying sketch. Overflow from the trough is delivered to a launder and distributed over amalgamating plates. The mill has been running about ten weeks and has attained as much as 150 tons' capacity per 24 hr. with a 1-to-1 pulp density in the classifying trough. However, it is now operating at 75 tons' capacity with about 30 per cent solids



This "mill" is said to effect classification and reduction by impact in a single unit



Two views of rotary pipe conveyor

in the trough, the product all passing a 40 screen and 75 per cent passing an 80 screen. Heads are estimated to be about $3 per ton, tailings 65c. per ton, and no attempt is being made to save the iron sulphides. Operating costs have been estimated to be under 50c. per ton.

It is stated that the present mill operates most satisfactorily on run-of-mine material and does not give satisfactory results on soft material or when handling crushed ore. It seems to depend upon a mixture of hard and soft ore, heterogeneous with respect to size. Obviously, the circulating load is an important factor as well. To date, wear and tear have been negligible. An attempt was made to operate the mill as an amalgamator, but this was not successful, and outside plates were added.

The idea of the mill is novel and its limitations and possibilities can be determined only by an extensive series of experiments.

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Rotary Pipe Conveyor

A new agreement has been made by The Dorr Company with E. W. Davis covering the handling of the rotary pipe conveyor. The company now has exclusive world rights for its manufacture and sale for use in connection with closed-circuit grinding.

The conveyor, which is shown in a sketch, is a cylindrical steel pipe, to the interior walls of which are attached angle-iron ribs, longitudinally placed in reference to the pipe. As the pipe revolves, these ribs, extending inwardly, keep the material being handled in a state of agitation. As a result, pulps of low moisture content are kept fluid by being prevented from segregating and by eliminating friction that would otherwise occur between the solids and the pipe wall.

A special feed scoop provides the force for moving the pulp through the conveyor. The lifters impart no forward motion to it but simply prevent segregation, enabling the pumping action of the feed scoop to force the pulp through the pipe. Adjustable opening slots at desired points along the pipe allow multiple-point discharge. Discharge may be at either or both ends, or at any number of intermediate points. Where pick-up is desired at more than one point, a corresponding number of feed scoops must be provided with the conveyor.

This conveyor is said to be suited for the following in connection with closed-circuit grinding: Conveying and distributing feed from grinding mills to wide classifiers; feeding classifiers of any width where loss of head is to be avoided; feeding bowl classifiers in closed-circuit; feeding classifiers in closed-circuit with compeb mills, as in the grinding of cement raw materials; feeding ball, rod, or compeb mills from classifier sand discharge, where loss of head is to be overcome, or distance is too great for gravity flow, and feeding mills or classifiers where unnecessary dilution is objectionable.

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Combating Pipe-Line Corrosion

As a result of the study of corrosion on underground pipes, which the Bureau of Standards has been carrying on for several years, a new instrument has been developed for simply and quickly measuring the electrical resistivity of soil in place, without the necessity of sampling. The Bureau has found that soils high in soluble salts, and therefore low in electrical resistivity, are usually highly corrosive to pipe lines. Such soils are frequently found as naturally occurring outcrops or pockets in areas of otherwise normal or high resistivity. The predetermination of such areas is a matter of importance to any company having a pipe line to maintain, as this knowledge will enable the company to give it suitable protection.

The new instrument is known as the Shepard earth resistivity meter. It consists of two rods or canes tipped with iron electrodes. A flashlight battery and milliammeter are mounted in a light aluminum frame on one of the rods. The rods are pushed into the earth with a separation of about one foot or more, at the bottom of a pair of auger holes, a shallow excavation, or the side of an open trench. The circuit is then closed and the resistivity of the soil is read directly in ohm-centimeters on the scale of the instrument.

Polarization has been overcome or minimized in a unique manner, by which an accuracy closely approaching that of a.c. bridge determination has been attained. This has been accomplished by making the cathode much larger than the anode. Polarization, which is largely a cathode effect and is also a function of current density, is reduced by employing electrodes differing greatly in areas.

Two scales are provided on the meter, one ranging from 400 ohm-cm. upward and the other from 100 to 500 ohm-cm. Provision is also made for checking the voltage of the three-volt flashlight battery carried in the handle of the rod. The meter, which was developed by E. R. Shepard, of the Bureau of Standards, is being built and distributed by O. S. Peters, of 930 H St. N.W., Washington, D. C.

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Industrial Notes

Worthington Pump & Machinery Corporation, Harrison, N. J., has acquired the manufacturing and marketing facilities of Metalweld, Inc., of Philadelphia, builders of a complete line of portable compressors.

Interstate Equipment Corporation, 25 Church St., New York, has announced that its tramway department will handle B. & B. aërial tramways (hitherto manufactured by Broderick & Bascom Rope Company, St. Louis) and Automatic aërial tramways.

Ames Shovel & Tool Company, Hubbard & Company, the Wyoming Shovel Works, the Pittsburgh Shovel Company, and the Baldwin Tool Works have been merged into a new company known as the Ames Baldwin Wyoming Shovel Company. Executive offices for the present will be at North Easton, Mass.

Easton Car & Construction Company Easton, Pa., has purchased the Industrial Division of the business of the Lakewood Engineering Company.

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Bulletins

Drill Sharpeners. Holman Bros. Ltd., Camborne, England. New list describing No. 11 and 20 Twingrip drill-steel sharpeners.

Remote-Control Cars. Atlas Car & Manufacturing Company, Cleveland, Ohio. Bulletin No. 1239, automatic and remote control cars.

Electric Hoists. Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Bulletin No. 1829, small electric hoists.

Flexible Coupling. Morse Chain Company, Ithaca, N. Y. Bulletin No. 40, a small flexible coupling.

Vibrating Screens. Hendrick Manufacturing Company, Carbondale, Pa. Pamphlet entitled "Perforated Plates for Vibrating Screens."

Car Dumpers. The Wellman Engineering Company, Cleveland, Ohio. Bulletin No. 93, revolving car dumpers.

Power Transmission. Link-Belt Company, Indianapolis, Ind. New illustrated book No. 1293, silent chain drives, herringbone gears and speed reducers, steel and malleable chains, and P.I.V. gear.

NEWS OF THE INDUSTRY

Balatoc Mill Addition Ready; Benguet Ore Is Improving

In a semi-annual report from Manila, J. W. Hausserman, president of Balatoc Mining, operating a gold property near Baguio, in the Philippine Islands, states that completion of the work of doubling mill capacity to 300 short tons daily was expected to be accomplished by Sept. 1. A report for Benguet Consolidated, another gold producer in the same district and controlled by the same interests, states that the development results obtained in the mine are improving.

At June 30, Balatoc had total reserves of ore of 387,303 tons, averaging $20.17 a ton in gold. Of this 132,455 tons was in the No. 96 vein, which is both refractory and low grade. Development work on the 1,700 level, deepest in the mine, has opened 80 ft. of ore averaging $30 a ton in the 231 vein. A crosscut on this level is being continued to the 364 vein, the other important producer. On the upper levels, new ore is being developed in the 231 vein west of the oreshoot now under exploitation.

Benguet Consolidated had been unsuccessful in its previous attempts to develop ore at depth and some doubt had been expressed over the future of the property, the largest gold producer in the Philippines. However, work on the 600 and 700 levels has opened good ore and on the 800 and 900 levels, although the ore is erratic, there are indications of improvement. Ore reserves on June 30 were 344,340 short tons, valued at $4,177,700. This is a slight increase over the reserves on Dec. 31, 1930.

With respect to the Hartwell group, which Benguet had under development, the treatment of the ore indicates that grade is only about $21.50 a ton—compared with an average of $60 a ton previously estimated. Development is proceeding on the lode that extends into the property from Balatoc ground.

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To Search for Chihuahua Gold

An expedition is being organized by Pablo Lucero, treasurer of Casas Grandes municipality, Chihuahua, Mexico, to explore a region in the sierras of Chihuahua, said to be rich in gold. The zone, which is 100 km. long and 40 km. wide, is on the border of Chihuahua and Sonora states, north of the towns of Tres Rios and Dos Cabezas. Old church records of the territory indicate that twelve rich gold mines were operated in the zone during Spanish colonial times. These records report receipts of tithes from operators of mines in the area. Yaqui Indians, who jealously guard the zone in the mountains, are said to have exchanged large amounts of gold with Mormon colonies in the lowlands for arms, ammunition, and trinkets. Exploration is said to be dangerous because of the obstacles nature has placed in the way of man, and the frequent wars that are waged by the fierce Yaquis with other tribes.

■

Alaska Juneau Winze at 720 Ft.

Sinking of the development winze on the North orebody has reached a depth of 720 ft. below the main haulage level at the Alaska Juneau gold property, near Juneau, Alaska. The average grade of all samples from the top of the winze to 720 ft. is $5.40 a ton, compared with the grade of $2.01 shown by development work on the main haulage level for this orebody and with the grade of $1.20 a ton of ore from the South orebody, now being mined. The winze has shown progressive improvement in grade with depth. Lateral development has not yet been undertaken on a sufficient scale to indicate the extent of the ore. A sample taken at 720 ft. showed a grade of $7.71 per ton in gold. This ore will probably not be available for production for at least two years, as a new haulage tunnel may have to be driven at sea level.

■

Lease Vulture Gold Mine

According to a report from Wickenburg, Ariz., G. W. Prince, former assistant general manager of United Verde Extension, and A. B. Peach, of Prescott, have obtained a lease on the surface holdings of the old Vulture Mining & Milling property, which is held on an option by the U.V.X. The mill is being reconditioned at present. Concentration of low-grade material and dump ores is to start in about two weeks. The lease also includes privileges to work on the property at any point to a depth of 100 ft., which will be fully exercised, according to the lessees. A crew of eight men is now employed. U.V.X., as stated in a previous issue, suspended its exploration program at the mine sometime ago, after sinking the shaft to a depth of 500 ft. and completing considerable underground development work.

■

To Develop Mossback Extension

Dr. L. E. Daly, formerly of Oatman, and A. W. Woodhead have taken over the Mossback Extension group of claims, in the Silver Creek section of the San Francisco mining district, near Kingman, Ariz., and are preparing to deepen the shaft from its present depth of 75 ft. to water level.

Scossa Excited Again Over New High-Grade Strike

The camp of Scossa, Nev., is excited over the report of a new strike of high-grade gold ore, believed to be an extension of the original strike which created the camp last winter. At 80 ft. from the main shaft, the drift on the 180 level of the Dawes Gold Mines property, which includes the discovery ground at Scossa, broke into 3 in. of what is described as sensationally high-grade ore. The discovery was made on Sept. 3. The previous 80 ft. had shown a fair width of mill-grade ore, which is said to continue alongside the high-grade.

On the 100 level, the company reports developing 160 ft. of ore that averages $15 a ton over a width of 3 ft. Plans are now under way for construction of the first unit of a mill. Tests will be made to determine whether flotation or cyanidation will be used, in addition to amalgam plates. Dawes Gold purchased its property from the discoverers, the Scossa brothers, early in the year.

■

Finishing Gold Creek Dredge

Gold Creek Mining is completing the building of its dredge, near Gold Creek, Mont., according to M. Kerr Beadle, former Mayor of Butte and superintendent of operations. The company controls 5,600 acres of placer ground, which it purchased from Patrick Wall, of Gold Creek, and Harry Symons, Jack Cohen, and Charles R. Leonard, of Butte. The dredge will have capacity of about 8,000 cu.yd. per day. According to report made by Seymour Standish, Chicago engineer, 3,000 acres of the company's holdings are dredgeable, the gravel having a thickness of 27 ft. and assaying 35c. per cubic yard. Over 125,000,000 cu.yd. will be worked, according to a recent estimate. Arthur V. Corry, Butte engineer, who recently examined the property, stated that it was comparable to the famous Alder Gulch bonanza placer diggings.

■

To Develop Mercur Gold Mine

International Smelting, Utah subsidiary of Anaconda Copper, has advanced $25,000 for stock control of Sacramento Gold & Quicksilver Mining, operating at Mercur, Utah. This sum is to be spent for development work. A substantial body of gold ore, averaging $10 a ton, is said to have been developed in reopening the old tunnel. There is said to be 500,000 tons of low-grade ore carrying $1.65 to $2 a ton on the dump. D. E. Loughran is president of the company.

The Trepea mill, in southern Yugoslavia, is handling more than 700 metric tons of lead-zinc ore daily

Diamond Drill Shows Good Ore in Baltic Lode on Globe

In the Globe tract, south of the Champion mine, near Painesdale, Mich., one of two diamond-drill holes has cut the Baltic lode and found good ore. The other drill has about a month's work, it is estimated, before penetrating the vein. E. J. Longyear is doing the drilling for Copper Range. The fact that good ore now has been disclosed in three diamond-drill holes in the southerly extension of the Baltic lode is considered most encouraging. The southern section of the Champion mine has carried good ore in this lode. An extensive area on the lode is available in Globe lands, which are under option to Copper Range. Should the mineralization revealed by the diamond-drill cores be checked by lateral openings on the lode, the life of Copper Range will be prolonged many years.

Copper Range has only a half interest in the Champion mine, the largest and richest of the Copper Range properties, St. Mary's owning the other half, but it would have full ownership of the Globe property should it exercise its option. The option has been extended three years, which will give the company ample time to investigate the lode in that area.

■

Construction Delays Retard Moss Production Start

Excavating and installing foundations is now complete for a 100-ton mill at the Moss Gold Mines property, near Kashabowie, Moss Township, northwestern Ontario. This was formerly known as the old Huronia mine. It was the first gold producer in the province. Mill construction, which was to have been completed by the middle of September, has been somewhat delayed by lack of transportation facilities. At present the Northern Development branch of the Ontario government is assisting in cutting a truck road from the mine to Kashabowie station, a distance of 16 miles. Meanwhile the heavier machinery, including a new diesel power plant, has been unloaded and stored at the old Tip Top siding on the Canadian National Railway, awaiting completion of the road. The lighter supplies and mine timber are being transported to the mine from the Tip Top siding over a lengthy route of water trails and portages.

Sinking of the shaft has reached a depth below 600 ft., with three shifts of four men each and four drills. Levels have been opened up at 125-ft. intervals. Altogether a mile and a quarter of underground workings are available. The power plant at present consists of two 125-150 hp. horizontal boilers and two Sullivan steam-driven compressors of 538 cu.ft. each. An Ingersoll-Rand double-drum steam-driven hoist has been purchased from Sherritt Gordon Mines. It is now installed and operating.

■

Teck-Hughes Gold Prepares to Open New Deep Levels

Teck-Hughes Gold, of Kirkland Lake, Ont., is now making preparations looking to the opening of a block of five new levels below the No. 30 level, at 3,605 ft. An incline winze is now 50 ft. below this level and as soon as each new level is reached, the ore zone will be crosscut and drifting started. About the middle of October installation of the underground machinery for the south shaft is expected to be complete. Sinking to the No. 55 level, or 6,700 ft., will be started. Main haulageways will be established at every fifth level.

The No. 30 level is understood to be one of the bonanza levels of the mine, and parallel vein systems 120 ft. apart are being developed. The two mills are treating a little over 1,250 short tons a day, the third unit of the new mill having been completed last March. For the quarter ended May 31, gross income was $1,758,000 and net income $1,175,000. For the nine months ended May 31 277,670 tons were treated, the average yield being $15.84 in gold and silver a ton and operating costs, $6.48.

■

Shanjay Builds Quicksilver Unit

A 22-ton Newhall quicksilver furnace has been completed by Shanjay Quicksilver Mining at its property near Wilbur Springs, Colusa County, Calif.

New Mexican Labor and Tax Laws Put in Operation

Within the last month, the Mexican government has put into operation an entirely new code governing the employment of labor, as well as a new tax on gross receipts. These two measures are expected to counterbalance, in large part, the benefits derived by mine operators from the exchange premium that resulted from the adoption of new currency standards recently. The labor law, which supplants the various conflicting state codes and which is the result of many years of revision, went into effect on Aug. 28, when it was first published in the *Diario Oficial* of the Mexican government. The tax law, passed early in August, is retroactive to 1930 and first payments fall due on Sept. 17.

Probably the greatest change in operating conditions which the new labor law will effect will be in working hours. A maximum shift of eight hours during the day, seven hours during the night, or seven and a half hours for the intermediate shift is allowed. In industries that require continuous operation—such as metallurgical plants—this regulation will mean that operators will be confronted with the alternative of paying at double rates for 1½ hours of overtime a day or of adopting a four-shift basis, with all shifts six hours long. In all, the labor code contains no less than 685 separate articles and is published as a document of 80 two-column pages.

Many of the articles will require considerable interpretation and operators are unable to tell, until the details have been evolved, exactly what the effect of their enforcement will be. One important mining company states that, by careful adjustment, it believes that only small increases in operating costs will be incurred.

The new tax, which is an extraordinary one levied for the purpose of raising additional funds at present, amounts to 1 per cent of all receipts. The Minister of Finance, Montes de Oca, received so many protests that an inquiry into its application is being made and the date of the first payment has been postponed. Precisely what allowances will be made to mining companies is not yet known.

Extend Britannia Tunnel as Drills Show Ore at Depth

Extension of the 4,100-level tunnel to cut the main ore-bearing formation at the Britannia copper property of Howe Sound, at Britannia Beach, B. C., has been started. The tunnel will be continued a total distance of 10,000 ft. and will open up virgin territory 1,400 ft. below the present lowest operating level —the 2,700. Development work, chiefly drilling, to determine the continuation of the Britannia orebodies at depth, has been under way since 1929 with the object of proving sufficient ore to justify continuing the tunnel. This work has been successful in developing a reasonable tonnage. When the 4,100 tunnel is available for direct exploitation of the orebodies, important economies in haulage costs are expected, as its portal is at mill level. About two years will be required to complete the work.

At present, the 2,700 level is the main haulageway, having supplanted the 2,200 level in 1928. The 4,100 level, which is connected to the 2,700 by a raise near its portal, will be 9x12 ft. A four-unit drilling carriage, equipped with No. 17 Gardner-Denver machines, will be used in driving. A 30-hp. electrically operated scraper will handle the broken material.

■

Despite Predictions, Silver Conference Call Unlikely

Despite predictions to the contrary, President Hoover is not likely to issue an invitation to interested nations to attend a silver conference. He has expressed the opinion that frank discussion of the situation at an unofficial conference probably would be helpful. In that connection he called attention to the better understanding of the wheat situation that followed the informal London conference.

Apparently the President has no objection to an official international conference, but he is of the opinion that the United States should not extend the invitation. Silver has a bearing on fundamental policies of the British and of the Chinese. Since their governments have not seen fit to propose an international conference, the President seems disinclined to comply with the request of the Senate that he call such a conference.

Senator Key Pittman, of Nevada, stated at Spokane on Sept. 1 that President Hoover would call an international silver conference within thirty days. Senator Pittman recently returned from the Orient, where he went to study the silver situation and the effect of the decline in the price of the metal on Chinese consumption.

■

El Tambor Property Closes

Permission to suspend operations at his La Estrella mine, said to be one of the richest workings in the El Tambor district, Sinaloa, Mexico, has been granted Manuel Llantada by the Department of Industry, Commerce and Labor. No reason has been given for the suspension. Anticipating that other suspensions will follow in the region, El Tambor miners' unions have petitioned President Pascual Ortiz Rubio to prevent further shutdowns. (La Estrella seems to be a one-man owner property. According to information obtainable in Mexico City, the mine employs about 50 men and has been functioning since April last.)

■

Fresnillo Ore Good at 470 M.

In agreement with the lead cartel, lead output at Fresnillo Mines, Zacatecas, Mexico, has been reduced 15 per cent as from May 1. Development is being maintained at normal rates, the Cueva Santa vein continuing to open up favorably with depth. The new 470-m. level, which has now more than 1,000 ft. of ore averaging about 4.5 ft. wide developed, shows higher silver and copper assays than any level yet opened as well as normal lead-zinc grades.

Up to the end of the second quarter, about 630 ft. of ore had been proved at 515 m. and 500 ft. at 570 m. The oreshoots have a total length of nearly 3,000 ft. on the 425-m. level, so considerable work remains to be done. Sinking and enlarging the general shaft below the 425-m. level to provide for operation of skips to that level has been completed. Steel timbering and ore pockets are being installed.

■

Potosi Mining Wages Cut

All wages and salaries at the property of Potosi Mining, in the Santa Eulalia district, Chihuahua, Mexico, were cut 10 per cent, effective Aug. 1. Production, which was reduced 15 per cent in May in accordance with the decision of the international lead cartel, has been cut an additional 5 per cent and is now at the rate of 7,075,000 lb. of lead monthly, compared with the normal rate of about 9,000,000 lb. Development is being continued at the normal rate, however, with satisfactory results obtained in the lower levels of the mine.

■

Alaskan Chromite Possibilities

The Alaska Road Commission is at present engaged in surveying a road from a salt water harbor in Tutka Bay to the Red Mountain chromite deposits in the Kenai Peninsula, of south central Alaska. The distance is about 6 miles. High-grade ore at Red Mountain is a hard lump ore, assaying 54 per cent Cr_2O_3 and less than 12 per cent iron, according to W. P. Lass, of Whitney & Lass, local mine owners. Prof. A. C. Gill, in U. S. Geological Survey Bulletin No. 742 estimated one of the Red Mountain deposits to contain 90,000 short tons of shipping ore and 80,000 tons of lower-grade material, from which a possible 32,000 tons of concentrate might be recovered.

Western Lead Smelters to Reopen After Shutdown

Preparations are being made by Western lead smelters to resume operations after their suspension, which started in July. The first of the plants to resume will be the East Helena smelter of A. S. & R., which treats concentrate from Idaho and Montana lead mines. It was closed on July 1 and will start again on Sept. 15 on a one-furnace basis. About 200 men will be employed. J. D. MacKenzie, manager, states that an improved lead market in the Orient, and the reduction in surplus lead stocks have made possible reopening the plant two weeks earlier than planned.

The Murray unit of American Smelting & Refining, which also closed on July 1, will reopen on Oct. 1 and will also operate only one furnace. W. J. O'Connor, manager, states that 250 men will be employed at the Utah smelter. The company's nearby Garfield copper plant has continued to operate. International Smelting will reopen its Tooele lead smelter on Oct. 15, production having been suspended on July 15. The company, a subsidiary of Anaconda Copper, will employ 600 men in its smelting and flotation plants.

■

Morenci Cuts Working Time

Working time of all surface departments of Phelps Dodge at Morenci, Ariz., has been reduced to four days a week. The new regulation applies to such departments as machine shops, repair shops, carpenter crews, surface gangs, sawmill, and all other departments that can be operated on the shortened schedule. The men affected by the change have been working five days per week. Both mine and mill will be shut down from 11:30 p.m. Friday until 3.30 p.m. Monday. The company railroad will not operate Saturdays, Sundays, and Mondays, and the smelter will not operate for 3 days each week, its production being limited to 3,000,000 lb. of copper per month.

■

St. Lawrence Mine Closed

Anaconda Copper closed the St. Lawrence mine, one of its smaller units at Butte, Mont., at the end of August. About 300 miners had been employed at this property. Some were transferred to other mines in the district. The suspension was in line with the company's policy of centralizing operations at its larger, lower-cost shafts at Butte and completely suspending work in the less profitable units.

■

Wages at Inspiration

In the issue of Aug. 24, on p. 181, statement was made that Inspiration Consolidated in the Globe-Miami district, Arizona, had cut wages 9 per cent. This statement is wholly inaccurate, and apologies are tendered to the Inspiration company for the mistake. A correct account of the wage situation at this copper property was published on p. 83 of the July 27 issue, in which it was made clear that a small reduction had been made in the pay of workers getting more than $1,800 annually.

Government to Investigate Chilean Nitrate Trust

Complete investigation of the Chilean nitrate trust, Cosach, will be undertaken by the National Tribune at Santiago. The change in government, which occurred early in August, has evidently created a change in official sentiment toward the great combine, formed within the last year and a half to consolidate the country's leading industry. Cosach owns all the important nitrate lands and plants in Chile. It, in turn, is owned by the Chilean government (holding half of the stock) and the former nitrate operators. Export taxes have been removed and production has been centralized at low-cost plants to permit Chilean nitrate to compete with synthetic production in the world markets.

American interests in the combination (largely those of Anglo-Chilean Consolidated Nitrate) have stated they will not object to investigation, if it is fairly conducted. Among charges made against Cosach is one that excessive payments had been made for good will and patents covering the Guggenheim extraction process. E. A. Cappellen Smith, head of Anglo-Chilean, which held the patent rights, has denied charges of favoritism. The Guggenheim process has been put in use at the Maria Elena and Valdivia plants, the largest in Chile. At the time of the consolidation, Anglo-Chilean had a large funded debt and had shown losses, after depreciation and interest charges, ever since operation was started.

■

Electrochemists at Salt Lake

About 100 delegates attended the sixtieth annual convention of the Electrochemical Society at Salt Lake City, Sept. 2-5. Prominent mining men who addressed the convention included J. O. Elton, of International Smelting; Prof. A. M. Gaudin, of the Montana School of Mines; Prof. J. A. Fulton, of the Mackay School of Mines; and W. Mont Ferry. A round-table discussion of silver problems was included in the meeting, as well as a discussion of the use of cyanides in metallurgy. Dr. E. F. Northrup was presented with the Edward Goodrich Acheson medal for achievement in electrochemistry.

■

Leadville Smelter Reopens

Operation of the Arkansas Valley lead smelter of American Smelting & Refining, at Leadville, Colo., was resumed on Sept. 1 after a suspension that lasted the summer. About 175 men are employed. The plant is now the only smelter running in Colorado, receiving concentrate and ore that was formerly shipped to the Durango smelter by San Juan Basin mines. In August, Shenandoah-Dives Mining, at Silverton, shipped 32 carloads of copper-lead concentrate to Leadville.

■

To Remodel Boss Tweed Mill

Final financing has been done looking toward the operation of the Boss Tweed and Clipper gold properties in the Pony district, Madison County, Mont., according to R. E. Sawyer, manager. The mill will be enlarged to a capacity of 200 tons per day and will consist of amalgam plates and flotation units. The property was financed by Japanese interests of the Pacific Coast.

■

Report Bodie Surface Strike

A strike of high-grade gold ore is reported to have been made on the surface of its Bodie holdings, in California, by Treadwell Yukon. The discovery was made while doing surface work near the old turntable. No information is available on present rate of production at this gold property. R. J. Duncan, mine superintendent, recently examined the Aurora district.

■

To Prospect for Congo Copper

A prospecting syndicate has been formed in Brussels with a capital of 30,000,000 fr. as a result of the copper discoveries made in southeastern Katanga, near the Union Minière properties. The leading shareholders in the syndicate will include Union Minière, the Katanga Special Committee, and the Compagnie du Katanga. Katanga Special Committee is a semi-governmental organization, with a capital of about 120,000,000 fr. Reference to the new deposits, which carry copper in sulphide form, was made at the annual meeting of Union Minière.

■

Big Jim to Sink to 900 Ft.

The main shaft of the Big Jim mine, at Oatman, Ariz., will be deepened from the 600 to the 900 level, according to an announcement by G. A. Keating, general manager. When the shaft has reached the lower level development drifts will be started and a connection will probably be made with the Aztec workings of the Tom Reed.

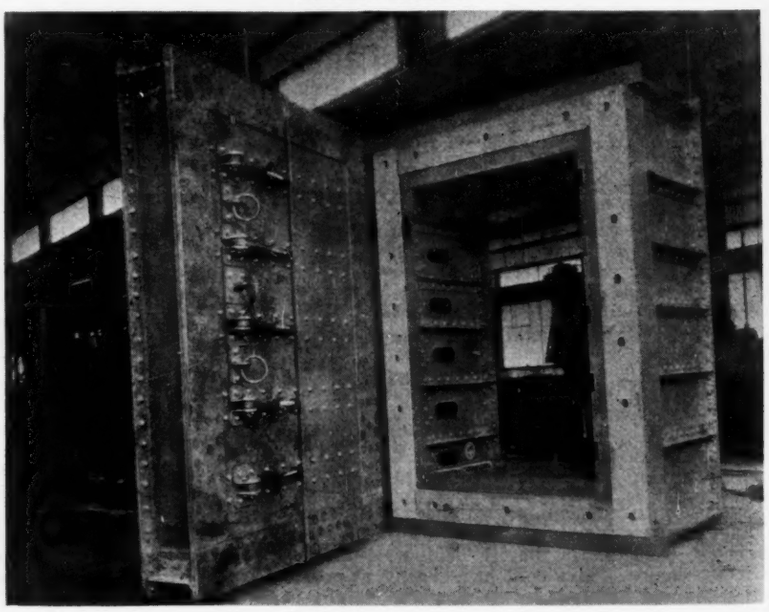
Cerro Makes Good Time in Driving Mahr Tunnel

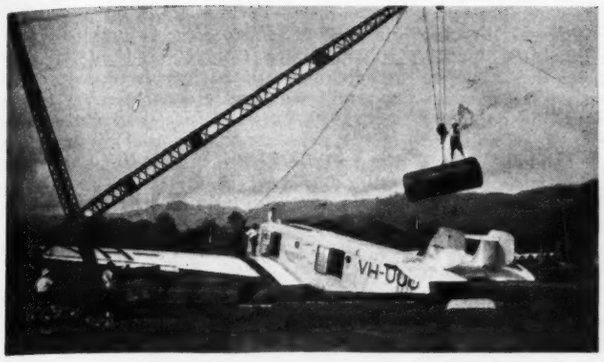
Driving of the new Mahr tunnel at the Morococha unit of Cerro de Pasco Copper, in the Department of Junin, Peru, is making excellent progress. On Aug. 1, the tunnel had been driven 10,889 ft. of the total of 30,153 ft. that is called for by the company's plans. In July, the total driven was 874 ft., all through shale. This is the best footage accomplished in any one month and compares with a monthly average of 679 ft. so far this year. Actual driving of the tunnel was started in 1929, under the direction of A. Guthrie & Company, consulting engineers.

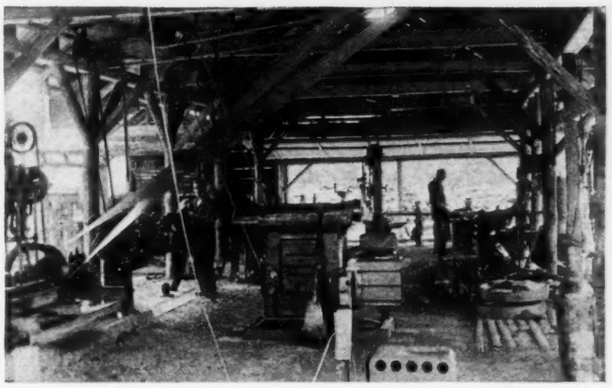
This new tunnel, which has its portal at Mahr station, on the Central Railway of Peru, will connect with the San Francisco shaft, of the Morococha group. It will be about 500 ft. below the present deepest workings, now 1,200 ft. deep, and will serve to drain the mines, which have always been confronted by a serious water problem and have been handicapped by pumping costs. The tunnel is 12 ft. high and 10 ft. wide at the bottom, tapering to 9 ft. at the top. About 20,000 to 25,000 g.p.m. of mine water will probably be handled when the connection with the workings is completed. In addition, of course, the tunnel will traverse a possibly mineralized section of the company's holdings and may well cut new ore deposits.

Most of the formation encountered in driving is andesite breccia and tuff, but shale was encountered on June 9 and driving in it was continued until Aug. 5. About 170 Peruvians and an American staff of seven are employed in this tunnel work. In the beginning, the Peruvians were unfamiliar with the work, but they learned rapidly and all South American records for tunnel driving have been broken. During the record month, only 23 days was spent in actual advance, the remaining eight days being used for timbering. Electrical shoveling and transportation equipment is used.

Underground bulkhead, for the N'Changa mine, built at N'Kana, Northern Rhodesia







At the Bulolo Gold Dredging property in New Guinea: upper left, unloading a 5,400-lb. boiler at the airdrome; upper right, caterpillar tractor and trailer in front of the company store; lower left, preparing the ground for the flume of the hydro-electric plant; and lower right, the workshop

Bulolo's Air Transportation Speeds Construction

Dredge construction by Bulolo Gold Dredging at its properties on the Bulolo River, New Guinea, is now making rapid progress. As related in articles published in this magazine, the enterprise is unique in that airplanes were proposed and are now in use for transportation of dredge parts and materials from the seaboard to a point in the interior of New Guinea. Airplane transport of the dredge material began April 4, 1931, and to the end of August over 600 short tons have been taken in by the two all-metal Junkers planes of the low-wing type, each powered by three American Hornet 525-hp. engines—a total of 1,575 hp. for each plane. Including the interval devoted to preliminary work, about 900 tons of materials and machinery has been transported by airplane to the dredge erection site. The first load carried on the Junkers planes was 3,200 lb. in weight. Load weights were gradually increased. Each plane weighs 10,640 lb., the maximum permissible load is 8,110 lb., and total weight 18,750 lb.

The hull of the first dredge is about 50 per cent complete; the power plant and tunnels are about 80 per cent complete. Tunnels on the hydro-electric plant, five in number, have been completed. As preliminary work, airdromes were constructed both at Lae and at Bulolo. At Lae a wharf with locomotive, crane, a railroad about 1 mile long (to the Lae airdrome), and warehouse and staff headquarters were completed. Barges are used for transferring from shipside to wharf. The airdrome at Bulolo is 1 mile long and ¼ mile wide and is at the edge of the dredging area. A stiff-leg steel derrick is used for unloading the plane. Erection derricks are placed at each dredge site. Temporary living quarters have been erected also, as well as a steam power plant, two saw mills, machine and blacksmith shop, and an ice plant. Most of the machinery for for the dredge and power plant is either in New Guinea or in transit. The first dredge will be in operation by March, 1932, officials hope. So far, the schedule planned has been maintained. Lumber is now being cut for the flumes, 80x5 ft. in cross-section.

Dredge hulls were constructed in Sydney, Australia, as well as the barges and parts of the headworks of the hydro-electric plant. Part of the dredge machinery was constructed in California by the Yuba and Natomas companies. The electric generators for the power plant were constructed in England and the turbines in Sweden. Germany supplied the Junkers planes. Thus, many sources supplied the equipment and materials from a wide geographical range.

The power development starts above the principal Bulolo leases on the Bulolo River. A diverting weir will bring the water to a 2,900-ft. open ditch, 3,173-ft. timber flume, and 1,637 ft. of tunnels. The ditch section is 80 sq.ft. and the grade 1:1,000. Flumes are 8x5 ft. in section; grade is 1:500; tunnels are 8x8 ft. in section; grade is 1:500. A surge tank connects to two 46-in. steel pipes, 250 ft. in length. Net head is 105 ft. Power-house equipment is two turbine-generator units, each of 600 kw., with overload capacity to 700 kw. Switch banks, an overhead crane, and the usual accessories complete the equipment. Turbines were made by Boving & Company, of Sweden, and generators and accessories by Metropolitan-Vickers, of England. Provision has been made for a third unit. It is estimated that the cost of power-plant operation will be about $11,000 per annum.

The parent company, Placer Development, Ltd., has acquired contiguous ground, now being drilled. From results, expectations are that a larger area will be worked in the new Bulowat field than in the present Bulolo holdings.

Dredge design was supervised by Frank W. Griffin, a director of the company. Griffin brought the weight limits of the dredge parts down to the limits imposed by air transportation without greatly increasing their cost. Thomas D. Harris is in charge of operations in the field, where 75 white employees and 500 natives are at work. Frank R. Short, chief field engineer of Placer Development, has been in New Guinea for the last year in connection with the examination of the Bulowat area. Charles A. Banks, of Vancouver, is managing director of both companies. W. A. Freeman, of Sydney, Australia, is president of the Bulolo company.

■

Build Road to Balsas Mines

Arrangements are being completed for intensifying activities in gold and silver holdings he owns near Balsas, Guerrero, Mexico, by Luis Castilla, well-known Mexican mine operator. Castilla announces that he plans to build a road to facilitate movement of ores from his properties, because of inadequate railroad service in the region, which, he declares, prevents Guerrero from becoming one of the most flourishing mining states in Mexico. According to Castilla, some of his Balsas mines produce as high as 18 k. of silver per ton.

Work Suspended at Chambishi by Mufulira Copper

London, Sept. 3.—Because of important developments of high-grade ore at the Mufulira property of Mufulira Copper Mines, the company has decided to suspend all work at its Chambishi property. The Mufulira mine alone will easily be able to supply sufficient ore for the 1,500-ton mill now under construction by the company, and it will not be necessary, therefore, to exploit Chambishi's reserves of high-grade ore for the present. The properties lie within a short distance of each other in northeastern Northern Rhodesia.

. . . . A new agreement is being drawn up for the financing of Mufulira Copper. This company is completely owned by Rhodesian Selection Trust, Rhokana Corporation, and British South Africa. It is being financed by advances from American Metal and Lehman Corporation, American organizations with big interests in Rhodesian Selection. These companies have already advanced £1,093,750, of a total of £1,500,000 guaranteed. An issue of 6 per cent, tax-free debentures will be created with a nominal value of $12,500,000 in U. S. gold currency. The debentures will be issued at the rate of $500 for each £100 advanced.

. . . . Rhokana Corporation, potentially the largest of the new Rhodesian producers, has proved and purchased the King Edward property, 30 miles west of Lusaka. It will furnish millions of tons of pyrite flux for the treatment of N'Changa oxide ores.

■

Operating Company Formed to Work Mount Coolon Mines

London, Sept. 1.—Mount Coolon Gold Mines has been registered in Australia to take over the properties at Mount Coolon, Queensland, which have been under development during the last year by Gold Mines of Australia. Formation of the new company is taken as an indication that development has been satisfactory and that large-scale production can now be attempted. The capital of the new company is 800,000 shares, of 10s. par value. Of this, 600,000 shares will be issued at present—130,000 to Gold Mines of Australia in exchange for the development work done and the option, and 470,000 shares to be sold for financing. The shares will be offered publicly in Australia.

. . . . Carl O. Lindberg, of New Consolidated Gold Fields; G. C. Klug, of Zinc Corporation; and Charles G. Gibson, geologist, have all reported favorably on the property, which is expected to become an important producer. The board of directors of the new company will include representatives of the important Australian companies that associated to form Gold Mines of Australia. Colin Fraser, chairman of the board of Broken Hill South, and managing director of Broken Hill Associated Smelters, will be the chairman of the new company. Other members will include E. H. Shackell, of Electrolytic Zinc; Alex Campbell, of North Broken Hill; and Mr. Klug.

. . . . Herr Stahl, general director of Mansfeld Mining & Smelting, operating copper properties in the Eisleben district, Germany, reports that as a result of low copper prices, the company is losing £30,000 a month, in spite of government subsidies totaling about £22,500 monthly. A public meeting will be held to take immediate measures that will insure continuation of work during the depression. Mansfeld is the largest copper-mining organization in Germany. [For a description of this property, see the Aug. 24 issue of *E.&M.J.*] A dispatch from Berlin states that Aron Hirsch & Sohn, large copper-refining and manufacturing company, has settled its credit difficulties.

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Transvaal Platinum Mines Consider Merging

Johannesburg, Sept. 1.—A proposal to amalgamate the several companies operating in the Rustenburg area of the Transvaal under the direction of a new holding company has been officially announced. The capital of the new company would be allocated to Waterval (Rustenburg) Platinum and Potgietersrust Platinums on the basis of the valuation of their respective assets. The scheme has been favorably received as considerably strengthening the outlook of the South African platinum industry.

. . . . Rustenburg's platinum deposits have been recognized as being of unusual size and persistence, but the erratic platinum market of recent years has made profitable exploitation impossible. Recently the price of the metal has been considerably improved as the result of an agreement among the principal producers. Merging of the leading Transvaal mines would make fulfillment of this agreement more certain.

. . . . Potgietersrust Platinums, capitalized at £1,962,500, belongs to the Johannesburg Consolidated or Barnato group of South African mines. A 300-ton mill was put in operation in January, 1930, but was forced to close later in the year because of the low price of the metal. Either sulphide or oxide ore can be treated in this unit. Waterval (Rustenburg) Platinum is capitalized at only £275,000—although a considerable number of shares was subscribed for at a premium. The company has a 300-ton plant for the treatment of oxide ore only. Most of the ore reserves (which totaled more than 7,690,000 tons on June 30, 1930) are of sulphide ore, however. The company was able to show a small net profit in the 1930 fiscal year. Results for the current year are not available. South African production in recent months has been about 12,000 oz. of crude, containing 30 per cent platinum, a month.

. . . . A recent press report of a strike of high-grade ore in the City Deep property has now been officially denied. However, official statement was made that the position of the mine, long operating at a loss, is improving. In accordance with the program announced, production has been reduced from the former basis of 95,000 tons monthly to about 86,000 tons. In July, the company handled 87,500 tons, from which 22,146 oz. of gold was recovered. The operating losses, which totaled £7,649 in the first quarter of 1931, were reduced to £4,840 in the second quarter.

. . . . According to government figures, diamond production of the Union of South Africa in the first half of 1931 showed a shrinkage of no less than £1,500,000 in value from the production in the same period of 1930. Monthly figures for diamond output are not published. Other mineral output, however, is being well maintained and, of course, gold production shows an increase of well over 100,000 oz. compared with the record for 1930.

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Roan's Output in August

London, Sept. 8, 1931.—In August, the new Roan Antelope concentrator, in Northern Rhodesia, with all three units running throughout the month, handled 109,600 short tons of ore averaging 3.59 per cent copper. Production was 4,790 short tons of concentrate, assaying 59.16 per cent copper. (Copper content was 2,830 tons.) The fourth and fifth mill units will probably be put into operation whenever the smelter is ready—probably in November. In the meanwhile, the first three units are handling about 3,600 tons daily, compared with a rated capacity of 3,000 tons. Although some concentrate is already in process at the Carteret plant of American Metal, in New Jersey, U.S.A., it will not be on the market for some months yet.

. . . . Rhodesia Broken Hill Development, at Broken Hill, produced 27½ long tons of 90 per cent vanadium pentoxide from its vanadium unit. The zinc plant is now shut down.

Hedley Decides to Close

Vancouver, Sept. 1.—The results of diamond-drilling in the southwestern section of its Nickel Plate mine, at Hedley, B. C., having been unsatisfactory, Gomer P. Jones, general manager of Hedley Gold Mining, has resigned his position and announcement has been made that the compay will go into liquidation. The plant, which includes a 150-ton cyanide mill, will be sold. The Nickel Plate mine has been one of the most consistent gold producers in British Columbia, having operated for more than thirty years and produced more than $14,000,000 in gold. For several years, however, the company has been depleting its ore reserves without making more than a small operating profit, operations being maintained only in the hope that new ore would be developed. According to Mr. Jones, up to Dec. 31, 1930, 514 drill holes were put down to prospect the property. About 2,000 ft. of additional work has been done this year.

BRIEF NOTES

A. S. & R. Closes Matehuala. The Matehuala smelter of American Smelting & Refining, which normally handles ore from the leading copper-silver producers in the Matehuala section of San Luis Potosi, Mexico, was closed down early last month. As a result, Matehuala mines are now shipping to the San Luis smelter, of the same company, although the tonnage produced is small. The Dolores mine, at Matehuala, has been closed since early this year, and Santa Maria de la Paz is producing far below normal. Kildun Mining has been shipping steadily to San Luis.

Anglo-American Minerals Ships. A small quantity of high-grade gold ore is being shipped from the Anglo-American Minerals property, in the Black Mountains, 20 miles southeast of Florence, Ariz. Up to the end of August, shipments had yielded about 140 oz. The vein from which this is being taken was struck at a depth of 17 ft. The company is centering its interest on the possibilities of developing a deposit that can be mined with steam shovels and furnish sufficient tonnage to justify building a 500-ton plant. Fred Bowler is manager of operations for the company, a closed corporation backed by English capital.

Bralorne Progress Report. In a progress report covering operations at the Lorne mine from April last, when control was assumed by Bralco Development, statement is made that $35,000 has been expended to date on repairs, betterments and underground development. On the King vein, where 609 ft. of development was performed, 217 ft. of the main oreshoot has been exposed 162 ft. above the main tunnel. Ore is proved for a height of 400 ft. Outside this ore zone at tunnel level, diamond drilling cut the vein at three points, but as core recoveries proved unsatisfactory, further prospecting by this method has been discontinued. Ore was exposed by a raise on the Shaft vein for a distance of 45 ft. This subsequently pinched out, but was recovered later, and it now shows a width of 4 ft. at 100 ft. above the tunnel. A new company known as Bralorne Mines, with headquarters in Vancouver, has been formed. The capital is $1,000,000, Bralco holding 600,000 shares and Lorne Gold, 400,000 shares. H. C. Wilmot is manager at the property.

California Exploration Closes. All work has been suspended at the South Mountain property of California Exploration, near Silver City, Idaho. The property was taken over late in 1929 by a group of San Francisco operators, after having been idle for nearly 50 years. Although development done since then is reported to have yielded favorable results, the drop in metal prices combined with the distance from transportation has made exploitation impractical at present. Ore carries zinc and silver, with some lead, copper, and gold.

Callahan Drilling on 1600. Callahan Zinc-Lead is preparing to drill on the 1,600 level of its Galena property, near Wallace, Idaho. The company has suspended all other development work for the present. A series of holes driven from the east crosscut on the 1,000 and 1,200 levels have disclosed some good lead ore, showing a high ratio in silver, with widths varying from 1 to 5 ft. This ore is in the new south vein that has been under development for the last year.

Central Idaho Mill Starts. Operation of the new 25-ton mill, built at the property of Central Idaho Mining & Milling, 14 miles from Dixie, Idaho, has been started recently. The company hopes to ship its first carload of high-grade gold concentrate by Sept. 20, and from then on to maintain regular shipments of 40 to 60 tons monthly. High transportation costs will be the chief factor in determining the profits of the organization. A new tunnel is being started that will cut the vein 220 ft. below the present main working tunnel, which is 720 ft. below the surface. W. F. Newton is manager of the company.

El Cubo Shuts Down. Operations have been suspended at the property of Cia. Minera del Cubo, small silver-gold producer near Guanajuato, Mexico. Permission for suspension was obtained from the federal arbitration board, after an investigation had disclosed that production was being continued at a loss. The men were given advance pay. A 200-ton mill had been running.

Golden Cycle Unit Ready. Construction of a new flotation unit at the Golden Cycle mill, at Colorado Springs, Colo., was completed late in August. The company will treat Cripple Creek gold ores in this unit, which supplements a unit for complex-ore treatment installed last year.

Goldstone Mines Reopens. Operations are being resumed at the property of Goldstone Mines, near Baker, Lemhi County, Idaho. A 100-ton amalgamation and flotation mill was installed at this property in 1929 and will be available for production. The company was formed in 1928 to take over the mine, which consists of eleven claims carrying gold-silver-lead ore, and it has operated intermittently since then.

Macassa Mines Follows Ore. Drifting along ore on the 2,475 level of the Macassa Mines property, at Kirkland Lake, Ont., has opened 100 ft. that will average $10 in gold a ton over a width of 4 ft. The drift has been driven from the Kirkland Lake Gold workings and will eventually connect with the shaft being put down from the surface and now 600 ft. deep. Drifting on ore has been temporarily halted to permit exploration of parallel conditions. The company has been financed by New York operators and has 3,175,000 of its 5,000,000 shares outstanding.

Magma Reopens Properties. Magma Copper reopened its mine, mill, and smelter at Superior, Ariz., on Sept. 10 instead of Oct. 1, as had previously been announced. About 600 men will be given employment. The company ceased production on July 1.

Merger Plans Development. Resumption of development work on company account at the Bear Top property, near Murray, in the Coeur d'Alene district of Idaho, is planned by Merger Mines. A winze will probably be put down from the No. 3 tunnel level. At present, leasers are operating in the Simmons stope, above the No. 2 tunnel, and are shipping a small amount of ore to the Bunker Hill smelter.

Mohawk Builds Michigan Spur. A railroad spur is being built to the Michigan mine of Mohawk Mining in Ontonagon County, Mich. Ore from the development now being done along the Evergreen lode will be shipped for mill testing to determine the grade. As a good-sized stockpile is available, a fair indication of the copper content should be obtained. At last advices, the lode continued to show good grade for the entire length of the drift from the No. 15 level crosscut.

Montana Mines Buys Property. The Franklin mine, of the Thomas Cruse estate, has been bought by Montana Mines, which operates several properties near Helena, Mont. The new property covers 307 acres in the Scratch Gravel area of Lewis and Clark County. Some gold ore has been produced, but water has hampered exploitation. On the 500 level of its Spring Hill mine, now the largest gold producer in Montana, ore assaying $20 a ton has been struck, according to Gust Carlson, managing director. Negotiations for sale of a large block of Montana Mines stock to Eastern interests are now pending.

Pioneer Oreshoot Lengthens. Pioneer Gold Mines, in the Bridge River district, reports that on No. 8 level the oreshoot has now been opened for a continuous length of almost 1,900 ft. Recent development shows a gold tenor higher than average value, and stoping widths to be maintained. The new shaft from the 1,000 horizon is now approaching the No. 5 level. When communication is established with that point, sinking below the 1,000 level can start.

Rock Hill Gets Missouri Gold. Gold-mining rights on four farms near Allenton, Mo., have been secured by Rock Hill Quarries, a St. Louis company. The farms embrace a total area of 500 acres. If development work shows the presence of gold in paying quantities, a mill will be erected, according to Henry Billman, president of the company. Samples have been sent to government assay offices.

Teziutlan Development Stopped. Development work on the Minerva orebody at the Teziutlan unit of Mexican Corporation, in Puebla, Mexico, has been suspended, as a considerable tonnage is already in sight in this new orebody, which the company has been opening up during the last two years. The mill continues to handle between 175 and 200 tons of copper-zinc ore daily. With the recent improvement in London zinc prices, the company hopes to be able to keep losses at a low point.

Treadwell Yukon in Matachewan. An option on the Young Davidson Gold property, in the Matachewan district of Ontario has been taken by Treadwell Yukon. About six years ago 18,000 ft. of diamond drilling failed to disclose a deposit of what was then considered commercial grade. Results, however, indicated a substantial tonnage averaging from $3 to $3.50 a ton in gold. The company is also engaged in surface prospecting on a group of claims near Amos, Que. At the Errington property, at Chelmsford, operations consist mainly of exploratory drifting, crosscutting, and diamond drilling on the 1,000 and 1,500 levels.

Wright-Hargreaves Has New Ore. What is understood to be a new oreshoot has been found at the Wright-Hargreaves gold property, at Kirkland Lake, Ont. It has been followed for a short distance on both the 2,550 and 2,700 levels and is said to average $12.

MARKET AND FINANCIAL NEWS

Refined Lead Production Trends Downward

The trend in world production of refined lead continues downward. Daily rate of production for the month of July was 3,678 tons, against 3,995 tons in June, and 4,882 tons in July last year, according to the American Bureau of Metal Statistics. World output for July totaled 114,019 tons, of which the United States produced 32,157 tons, and the rest of the world 81,862 tons.

The fact that July production in the United States was a little higher than in June attracted no great interest, inasmuch as the increase reflected nothing more than the customary cleaning up at plants scheduled to close down.

Production outside of the United States declined from 89,132 tons in June to 81,862 tons in July. Total production of lead in the three months ended July 31 for countries outside of the United States registered a net decline of 15 per cent, contrasted with the preceding three months. July production for all countries except the United States was more than 20 per cent below the March, 1931, level.

Mount Isa, Australia, produced 877 short tons of lead bullion during June, and 2,476 short tons in July. This production does not appear in the following statistical compilation, which is on the basis of refined lead:

World Lead Production

In Short Tons

	May	June	July
United States	39,519	30,708	32,157
Canada	11,345	11,262	10,412
Mexico	18,426	21,093	18,421
Peru	.....	.....	.....
Germany	7,918	10,097	8,557
Italy	2,302	1,941	2,385
Spain and Tunis(a)	7,102	7,987	6,993
Europe(b)	16,000	15,700	15,100
Australia	13,129	13,037	12,096
Burma	6,698	6,815	6,698
Elsewhere(c)	1,200	1,200	1,200
Totals	123,639	119,840	114,019

(a) Partial. (b) Estimated or partly estimated Not specified elsewhere. (c) Partly estimated.

World Lead Production by Months

	1930 Tons	1931 Tons
January	153,772	146,710
February	148,298	138,120
March	163,177	146,789
April	153,779	131,926
May	157,270	123,639
June	150,541	119,840
July	151,356	114,019
August	155,364	.....
September	148,506	.....
October	152,616	.....
November	144,525	.....
December	153,840	.....
Monthly average	152,773	131,578

Note: Total production for 1930 was 1,833,281 tons

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	111.74
1926	107.74
1927	97.54
1928	99.78
1929	110.33
1930	82.87

	1929	1930	1931
January	106.86	102.94	67.62
February	110.37	102.28	65.90
March	122.71	99.93	68.03
April	116.36	93.24	64.45
May	110.03	83.41	59.81
June	109.66	78.57	58.23
July	109.58	74.58	59.54
August	109.81	74.41	58.05
September	109.29	73.42	....
October	108.52	69.63	....
November	106.09	71.39	....
December	104.75	70.65	....

Financial Notes

BALATOC MINING, operating a gold property in the Philippine Islands, reports net profit, after all charges, of 700,343 Philippine pesos on a production of 1,465,295 pesos in the first six months of 1931. Operating profit was 900,907 pesos. In the first half of 1930, net profit was 464,794 pesos on a production of 1,197,729 pesos, and the operating profit was 641,446 pesos.

MEXICAN CORPORATION reports that its Teziutlan copper-zinc unit, at Puebla, Mexico, incurred a loss, before depletion or depreciation, of $48,497 in the quarter ended June 30 last. Production was $112,096 in concentrate.

U. S. Tin Consumption Drops

Data compiled by the American Bureau of Metal Statistics show that United States consumption of tin in the manufacture of tin plate and terne plate was only 1,700 long tons in August, compared with 2,100 in July, 2,000 in August, 1930, and an average of 2,200 for the first eight months of the year. Consumption in the manufacture of babbitt metal is as yet unknown for August, but was 800 long tons in July, compared with 900 in June, 1,200 in July, 1930, and an average of 1,000 long tons for the first seven months of 1931. These uses account for about 55 per cent of the total of deliveries of foreign tin, which were 5,270 long tons in August, compared with 5,100 in July, 5,695 in August, 1930, and an average of 5,765 long tons for the first eight months of 1931.

In the production and export of tin plate, the German figures have improved considerably during the last few months, that country producing 14,530 long tons in July and 16,208 in June, with June exports at 5,492 long tons. Great Britain's exports and production have both been running well below last year's figures, and United States production took a sharp drop in August, being 110,00 long tons, compared with 141,500 in July, and 133,500 long tons in August, 1930.

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FRESNILLO MINES, lead-zinc-silver producer, of Zacatecas, Mexico, reports a net loss, after allowing for development but before depreciation or depletion, of $12,337 in the second quarter of 1931. The company's output was valued at $562,616 from 260,083 tons of ore. Lead output has been cut 15 per cent.

Mining Company Dividends for August, 1931

Companies in the United States	Situation	Per Share	Total Disbursements
Alaska Juneau, g	Alaska	$0.10 Q	$144,600
American Smelting & Refining	Various	0.50 Q	914,970
Anaconda Copper, c, z, l, s	Various	0.37½ Q	3,321,882
Homestake Mining, g	S. Dakota	0.50 M	125,580
Mohawk Mining, c	Michigan	0.25 Q	28,750
National Lead, pfd., "B"	Various	1.50 Q	154,913
New Jersey Zinc	Various	0.50 Q	981,632
United Verde Extension, c	Arizona	0.25 Q	262,500
Companies in Other Countries			
Cerro de Pasco, c, s	Peru	0.25 Q	282,710
Granby Consolidated, c	Canada	0.25 Q	112,500
Hollinger Consolidated Gold	Canada	0.05 M	246,000
International Nickel, pfd., c, n	Canada	1.75 Q	158,959
Teck-Hughes, g	Canada	0.15 Q	713,574
Total			$7,448,570

c, copper; z, zinc; l, lead; s, silver; g, gold; n, nickel; Q, quarterly; M, monthly.

Domestic Asbestos Output Increased During 1930

Commercial production of asbestos (figures available for chrysotile only) in the United States in 1930 increased 84 per cent in quantity, but declined 14 per cent in total value, compared with the record for 1929. With the exception of 1911, the 1930 production was the largest output of chrysotile ever recorded in the United States. According to figures compiled by the U. S. Bureau of Mines from individual reports furnished by producers, the total quantity of chrysotile sold or used by producers in the United States in 1930 was 3,653 short tons, valued at $273,292, as compared with 1,983 tons, valued at $317,584, in 1929.

Total average value, per ton, of chrysotile in 1930, including all grades of crude and mill fiber, was $74.81. In 1929 the corresponding value was $160.15. The marked decline in average value in 1930 is partly accounted for by the decrease in production of high-grade crudes, mined only in Arizona, and by the increased production of the lower grades of mill fiber produced in Arizona, California, and Vermont.

Compilation of reports from three producers of anthophyllite (amphibole), mined in Georgia, Maryland, and Washington, indicates a decrease in both quantity and value of this type of asbestos in comparison with 1929. Because of the limited number of operators producing this material, the figures may not be shown separately. The average value, per ton, including high and low-grade material, was $25-$30.

Chrysotile was mined in Arizona, California, and Vermont. There was a large increase in production of the mill fiber variety in Vermont, by the Vermont Asbestos Corporation, whose property is in Lamoille County, near Hyde Park. As compared with 1929, this corporation more than doubled the quantity of its sales in 1930, and the total value of the output was nearly twice that of 1929. Each producer in Arizona increased his output over 1929, but the total for this State showed a decrease because the number of operators dropped from 6 in 1929 to 3 in 1930.

Development work was continued at the chrysotile properties of the Arizona Asbestos Association (Subsidiary of Johns-Manville Corporation), at Chrysotile; the Bear Canyon Asbestos Company, Globe; and the Emsco Asbestos Company (nearest post office San Carlos). Adverse business conditions, however, prompted one operator to close down pending better times.

Exports of unmanufactured asbestos in 1930 amounted to 952 short tons, valued at $95,318, compared with 709 tons, valued at $108,467, in 1929, or an increase in 1930 of 34 per cent in quantity and a decrease of 12 per cent in value.

The United States is the largest consumer of asbestos in the world, but produces a very small percentage of its requirements—in 1930 only about 1.7 per cent. In 1930 Canada produced 242,112 short tons, valued at $8,390,163.

The apparent consumption of asbestos in the United States in 1930 is arrived at in the following manner:

	Short Tons	Value
Production (*a*)	3,653	$273,292
Plus imports	208,681	7,064,824
	212,334	$7,338,116
Minus exports	952	95,318
Apparent consumption (*b*)	211,382	$7,242,798

(*a*) Exclusive of a small commercial production of amphibole.
(*b*) Exclusive of material withdrawn from stocks on hand at end of 1929, for use in 1930.

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U. S. Phosphate Rock Output Increased in 1930

With occasional exceptions, the marketed production of phosphate rock mined in the United States has been steadily increasing. In 1930 the sales of this commodity reached the highest point in the last decade.

According to a statement by the U. S. Bureau of Mines, based on figures compiled from individual reports of the producers, the total quantity of phosphate rock sold or used in the United States in 1930 was 3,926,392 long tons, valued at $13,996,830. In comparison with 1929, these figures represent increases of 4.4 per cent in quantity and 6.4 per cent in value. The average value per ton in 1930 was $3.98, as compared with $4.02 in 1929.

Imports of phosphate rock, crude, into the United States in 1930 of 32,658 long tons, valued at $377,177, showed decreases of 27.3 per cent in quantity and 19.6 per cent in value, as compared with 1929.

Total exports of phosphate rock from the United States in 1930 (1,225,722 long tons) were greater than for any year since 1913, when 1,366,508 tons was exported.

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Production of Non-Metallic Minerals in Canada

The production of non-metallic minerals in Canada during 1930, according to the Dominion Bureau of Statistics, was as follows:

	Quantity, Tons	Value, Dollars
Actinolite	34	437
Barytes	66	1,484
Bituminous sands	2,067	8,268
Fluorspar	80	1,240
Graphite	1,535	96,392
Magnesite	13,336	336,162
Manganese, bog	275	1,650
Phosphate	40	760
Silica brick	(*a*) 2,418	97,379
Sodium carbonate	364	4,550
Sodium sulphate	31,571	293,847
Sulphur (*b*)	37,730	314,835
Total		1,192,417

(*a*) In thousands.
(*b*) Includes sulphur content of pyrites at its sales value and estimated figures for quantity and value of Sulphur in smelter gases used for acid making.

Aluminum Cartel Said to Face Dissolution

Indications point to the dissolution of the international aluminum cartel of producers in six European nations when the present agreement expires on Dec. 31 of this year, according to a report by William E. Heitz, the American Consul at Berlin.

The greatest difficulty to the continuance of the cartel lies in the fact that the members have taken to price cutting in order to keep their plants occupied to normal capacity, the consul reports. It is said that in April the cartel sold 6,000 tons to Russia at a price of about £78, although the official cartel price was fixed at £85 on Oct. 15, after having been stabilized at £95 for a period of two and a half years.

Even if it should be possible to reach an agreement by Jan. 1, trade circles believe that a further reduction in price would be necessary because of the volume of aluminum in stock, amounting to 150,000 metric tons, of which 17,000 has been accumulated in Germany.

Russia is said to be preparing to produce, and the European interests are giving close attention to American extensions into Canada. Import duties in the European market, however, have been the counter moves against increased competition.

A writer in the *Manchester Guardian*, England, recently reported that during more than four years of existence the cartel was "almost a model of harmonious cooperation—not only from the technical but also from the commercial point of view." In spite of the increasing severity of the world economic crisis, which eventually caused a market crisis for aluminum, and in spite of differences of opinion concerning the vital problems of the industry, the cartel relations between the financially independent and individually minded controllers of the aluminum industry in Europe not only remained friendly but grew even closer up to the moment of a dispute between Germany and Switzerland on the importation of raw aluminum into the former country from Switzerland, the writer said.

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Official F.M.S. Tin Output

The annual report of the Federated Malay States government shows the exports of tin concentrate in 1930, reduced to a metallic basis, as 62,065 long tons, compared with 67,041 tons in 1929. These exports are about 99 per cent of output, the report estimates. Employment in the industry at the end of 1930 was 89,517 men, compared with 113,415 men at the end of 1929. Wolfram and scheelite production showed slight increases, and gold output mounted to 28,888 oz.

Domestic Mica Sales Volume Up in 1930

The total quantity of uncut mica sold by producers in the United States in 1930 was 7,465 short tons, valued at $286,407, as reported by the U. S. Bureau of Mines. These figures (including sheet and scrap mica) represent an increase in quantity of 2.7 per cent and a decrease of 29.1 per cent in value compared with 1929. The decline in total value is due partly to the inclusion in 1930 of a larger proportion of scrap mica in total sales than in 1929. Of the total quantity sold, 733 tons (1,465,485 lb.), valued at $177,307, was sheet mica, including 1,253,782 lb. of punch mica, valued at $61,230, and 211,703 lb. of mica larger than punch, valued at $116,077. A very small quantity of uncut domestic splittings was reported by one producer and included in the sales of sheet mica. In addition to sales of sheet mica, 6,732 tons of scrap mica was sold in 1930, valued at $109,100.

The sales were made by eleven states: Alabama, Colorado, Connecticut, Georgia, Maine, New Hampshire, New Mexico, North Carolina, South Carolina, South Dakota, and Virginia.

Compared with the record for 1929, the sales of punch mica in 1930 decreased 28.4 per cent in quantity and 38.1 per cent in value; and mica larger than punch decreased 25.2 per cent in quantity and 38.0 per cent in value. Total uncut sheet mica sold showed decreases of 28.0 per cent in quantity and 38.1 per cent in value, compared with the 1929 data. Figures for scrap mica indicated increases of 7.7 per cent in quantity and 7.5 per cent in value.

The average value, per pound, of uncut punch mica sold in 1930 was about 5c.; and of mica larger than punch, about 55c. The average value, per ton, of scrap mica in 1930 was $16.21.

Total sales of ground mica in 1930 were 11,415,847 lb., valued at $319,831, compared with 11,585,383 lb., valued at $423,479, in 1929. The totals comprise 8,266,302 lb. of dry ground mica, valued at $158,808, and 3,149,545 lb. of wet ground mica, valued at $161,023.

Total sheet mica comprises punch mica, mica larger than punch, and splittings. The United States produces a very small amount of mica splittings, but imports large quantities for use in the manufacture of built-up mica. In 1930 the total quantity of uncut splittings (domestic and foreign) consumed in the United States was 3,035,880 lb., valued at $1,265,137, as compared with 3,782,287 lb., valued at $2,449,889, in 1929.

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1930 Talc Sales in U. S. Involved 179,385 Tons

In 1930 the talc industry as a whole experienced a depression, which was characterized by lessened demand, a tendency toward lower prices, and keen competition. Practically all producers, however, continued operations. Five new operators entered the field in 1930, one each in California and Nevada, two in North Carolina, and one in Vermont. Two small operators, one each in California and North Carolina, discontinued operations.

The total quantity of talc sold by producers in the United States in 1930 was 179,385 short tons, valued at $2,108,338, according to figures compiled by the U. S. Bureau of Mines. As compared with the record for 1929, these figures represent decreases of 19 per cent in quantity and of 20 per cent in value. The figures comprise 4,972 tons of crude talc, valued at $48,913; 385 tons of sawed and manufactured talc, valued at $90,370; and 174,028 tons of ground talc, valued at $1,969,055. There were 28 producers of talc in 1930—three more than in 1929.

Of the total quantity sold, New York State supplied 93,216 tons, valued at $1,192,604, as compared with 109,543 tons, valued at $1,439,272, in 1929, a decrease of 15 per cent in quantity and 17 per cent in value; Vermont supplied 45,881 tons, valued at $399,548, as compared with 60,469 tons, valued at $546,658, in 1929, or a decrease of 24 per cent in quantity and 27 per cent in value; and California supplied 14,993 tons, valued at $219,246, as compared with 17,620 tons, valued at $256,977, in 1929, or decreases of 15 per cent in both quantity and value. The output of talc from California, New York, and Vermont equaled 86 per cent in quantity and value, respectively, of the total sold in the United States in 1930. The remainder of the output was produced by Georgia, Maryland, Nevada, New Jersey, North Carolina, Pennsylvania, Virginia, and Wisconsin.

Slackened demand was reflected in the imports of talc for consumption in 1930, which amounted to 25,779 short tons, valued at $529,822, compared with 31,177 tons, valued at $671,629, in 1929, or a decrease of 17 per cent in quantity and 21 per cent in value in comparison with 1929. With the exceptions of 1928 and 1929, however, the tonnage imported for 1930 was higher than for any year on record.

Toilet grade talc is produced in quantity only in California. This grade of talc is dutiable at 75 per centum ad valorem, which enables the producers to compete more favorably with toilet grade talcs from Canada, France, and Italy. Despite other handicaps, such as freight rates and lessened demand, prices were about the same as in 1929.

Talc produced in New York is used principally in the paint, paper, rubber, and ceramic industries. Lower prices, declining demand, and sharp competition characterized the industry in this State. The same may be said of conditions prevailing in Vermont. The product from this State enters chiefly the roofing, paper, paint, rubber, and textile industries.

Talc crayons manufactured from high-grade massive talc were produced in Georgia, North Carolina, and Vermont. High-grade talc of lava grade was produced in Maryland and North Carolina.

The encroachment of substitutes for talc in some industries is well known and has made some progress, but as new uses are frequently being found for talc, this factor probably does not have a disturbing influence on the industry at present. The increased tariff rates on ground and manufactured talc (except toilet preparations), granted by the new tariff act, which became effective June 18, 1930, have apparently not had sufficient time to affect the domestic industry appreciably.

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Walker Mining Company

Walker Mining Company, controlled by the International Smelting Company, reports for the quarter ended June 30, 1931, a net loss of $10,968 after interest, depreciation, and inventory adjustment, but before depletion. This compares with a net profit of $2,899 in the preceding quarter, and a net profit of $45,993 for the June quarter last year.

For the six months ended June 30, 1931, the net loss was $8,069, against a net profit of $214,711 in first half of 1930. During the second quarter, the company sold 6,354 dry short tons of copper ore and concentrate for $263,470. In addition, the company had $325,975 in accumulated products on hand at the end of the quarter.

Domestic Uncut Mica Sold by Producers in 1929 and 1930, in Chief Producing States

	Sheet Mica						Scrap Mica	
	Uncut Punch Mica (a)		Uncut Mica Larger Than Punch		Total Uncut Sheet Mica		Short	
	Pounds	Value	Pounds	Value	Pounds	Value	Tons	Value
New Hampshire:								
1930	616,204	$29,275	56,860	$24,029	673,064	$53,304	449	$8,743
1929	913,552	48,885	71,226	33,772	984,778	82,657	1,657	35,977
North Carolina:								
1930	610,216	30,567	138,858	81,884	749,074	112,451	4,744	75,400
1929	737,473	40,081	156,727	110,212	894,200	150,293	3,245	53,855
Other States(b)								
1930	27,362	1,388	15,985	10,164	43,347	11,552	1,539	24,957
1929	101,019	10,023	55,131	43,348	156,150	53,371	1,351	28,069
Total:								
1930	1,253,782	61,230	211,703	116,077	1,465,485	177,307	6,732	109,100
1929	1,752,044	98,989	283,084	187,332	2,035,128	286,321	6,253	117,901

(a) Includes a small amount of uncut splittings.
(b) Alabama, Colorado, Connecticut, Georgia, Maine, New Mexico, South Carolina, South Dakota, Virginia.

Continued Slack Demand for All Metals But Prices Show Little Change

New York, Sept. 10, 1931—Metal prices held remarkably well during the last three weeks considering the dull demand, the variations in the London market, the weakness in the stock market, the drops in some other commodity prices, and the lack of any evidence of an improvement in industrial conditions. The volume of sales, however, was so small on some days as to make the price little more than a nominal one. Copper is still 7½c., delivered, though the position is easier. Lead, also, is unchanged, though offers of reclaimed lead at concessions have injured the demand for virgin recently. Zinc has not budged from 3.80c., and silver has been very stable at between 27 and 28c. Tin is about back where it was three weeks ago after a little upturn to 27⅛c. The minor metals and ores show no changes of importance, except magnesium.

Copper Dull at 7½c.

Copper business has been very small in each of the last three weeks, an average day's business being only about 500 tons in the domestic market. The custom smelters have continued to adhere to the 7½c. level for eastern deliveries, and 7⅜c. in the Middle West, and have monopolized the business as the large producing groups were unwilling to book anything below 7¾c., the basis on which fabricated products were being sold. Two or three weeks ago, the demand for copper at 7½c. was sufficient and in some instances more than sufficient to absorb all the offers at that level, so that sellers had a waiting list and were selling only for early shipment. In the last week conditions have become easier as what little demand there was has moderated, and 7½c. copper has been available as far ahead as next March.

The foreign market has been even duller than the domestic. Up to yesterday, Copper Exporters had booked only about 4,000 long tons since the first of September, and with the London quotation on electrolytic down to £34½, it was decided to reduce the c.i.f. price from 8 to 7¾c. thus bringing the export price to the same basis as the domestic quotation of the custom smelters. This reduced price was effective Sept. 10.

Resales of electrolytic copper were available yesterday at 7¼c., delivered, from a trading interest, and as demand has dried up at 7½c. it may be that first-hands will make further concessions in the next week. Another sizable increase in stocks of copper is almost certain to be reported for the end of August, and as long as production continues to exceed consumption few expect that copper prices can hold at even the present bargain level. No conference among leading copper producers to talk over the present plight of the industry seems likely before October, when some of the foreign officials are expected to arrive here.

Average Metal Prices for August, 1931

COPPER:	
Electrolytic, refinery	7.292
London Standard, Spot	32.572
London Electrolytic, Bid	35.388
LEAD:	
New York	4.400
St. Louis	4.225
London Spot	11.944
London Forward	11.994
SILVER:	
New York	27.524
London	12.815
Sterling Exchange	485.284
ZINC:	
St. Louis	3.817
London Spot	11.444
London Forward	12.028
TIN:	
Straits	25.738
London Standard Spot	114.875
QUICKSILVER	80.115
ANTIMONY	6.596
PLATINUM, Refined	40.000
CADMIUM	55.000
ALUMINUM, 99 Per Cent Plus	23.300

Fair Call for Lead

Demand for lead has been relatively better than for copper, especially in the weeks ending Aug. 26 and Sept. 2, which were better than any of the preceding weeks in July and August. Prices were stable at the previously quoted levels of 4.40c., New York, that being the A. S. & R. contract level, and 4.225c., St. Louis. In the last few days, however, a custom smelter in the East has accumulated a thousand tons or so of metal largely reclaimed from scrap, which it was unable to sell and therefore reduced its quotation on this material to 4.25c., New York. The lead is of good grade, equally as good as virgin for many purposes, but is not acceptable to all consumers. All of the primary producers have so far firmly maintained their prices at 4.40c., New York, and report that their sales are well in step with intake, so they are not disposed to meet the new competition. The only thing that might force them to is the possibility of bringing in foreign lead. The London market has declined quite regularly lately, almost to the point reached on June 4, when spot was £10⅜, but there is as yet no need to fear the importation of foreign bullion lead in competition with the domestic product.

Consumption of lead has apparently improved in the last two months, as sales for July shipment were over 40,000 tons, and for August shipment, close to 39,000 tons. Previous months had run between 31,000 and 37,000 tons. Sales for September shipment to date have been about 28,000 tons. Corroding grades have been fairly active this summer, at premiums of $2@$3 per ton over common, and recently some battery and cable manufacturers have been increasing their specifications on contracts. Lead producers are well satisfied with the present conditions.

Zinc Firm at 3.80c.

Zinc has now ruled at 3.80c. since Aug. 14, and sellers are as firm as ever at that level. Consumption has dropped off somewhat but is still ahead of production, both in High-Grade and Prime Western, and the stocks are in strong hands. Galvanizers and brass manufacturers report business as dull as ever, but zinc production has been cut so severely that this is not a weakening influence on the market. American Zinc Institute statistics for August showed an output of 21,467 tons and shipments of 23,599 tons, stocks thus dropping to 129,701 tons. Average number of retorts operating was 20,540 and the average daily rate of production, 692 tons.

The volume of zinc sales in the last three weeks has been somewhat improved over the business done earlier in August, and forward bookings by producers are unusually small, as are stocks in consumers' hands.

Tin Quiet

A little fillip to the tin market occurred at the end of August, when it was announced that an international tin pool had been formed with the sanction and interest of the governments of the countries in which the metal is produced. Metal was to be accumulated and sold for not less than £150 per long ton. The price went a little above 27c. for prompt Straits, but in the last few days, with the weakness in other London markets, again dropped below 26c. Total visible supplies of tin decreased only 1,314 long tons in August, being 56,741 at the end of the month.

Silver Shows Stability

The silver market has been dull and steady, with quotations varying between 27¼ and 28c. in the three-week period. India has been a small buyer. No tendency either up or down is apparent.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified.

Prices on the following metals are unchanged from the complete report published in the last issue: Aluminum, 23.30c. per lb.; bismuth, $1.50; cadmium, 55c.; cobalt, $2.50 less 35 per cent; iridium, per oz., $100@$105; nickel, per lb., 35c.; osmium, per oz., $60@$65; palladium, $19@$21; platinum, $40; and rhodium, $45@$50.

Daily Prices of Metals

Aug. Sept.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
20	7.275	25.80	4.40	4.225	3.80
21	7.275	25.80	4.40	4.225	3.80
22	7.275	25.80	4.40	4.225	3.80
24	7.275	25.85	4.40	4.225	3.80
25	7.275	26.35	4.40	4.225	3.80
26	7.275	27.00	4.40	4.225	3.80
Av'ge	7.275	26.100	4.40	4.225	3.800
27	7.350	27.00@27.125	4.40	4.225	3.80
28	7.275	27.00	4.40	4.225	3.80
29	7.275	27.10	4.40	4.225	3.80
31	7.275	27.10	4.40	4.225	3.80
1	7.275	26.75	4.40	4.225	3.80
2	7.275	26.70	4.40	4.225	3.80
Av'ge	7.288	26.952	4.400	4.225	3.800
3	7.275	26.55	4.40	4.225	3.80
4	7.275	26.05	4.40	4.225	3.80
5	7.275	26.00	4.40	4.225	3.80
7			— Holiday —		
8	7.275	25.70	4.40	4.225	3.80
9	7.275	25.70	4.40	4.225	3.80
Av'ge	7.275	26.000	4.400	4.225	3.800

Average prices for calendar week ended Aug. 22, 1931, are Copper, 7.275c.; Straits Tin, 25.783c.; New York lead, 4.400c.; St. Louis lead, 4.225; Zinc, 3.800c.; Silver, 27.271c.

Average prices for calendar week ended Aug. 29, 1931, are Copper, 7.288c.; Straits tin, 26.727c.; New York lead, 4.400c.; St. Louis lead, 4.225c.; Zinc, 3.800c.; Silver, 27.688c.

Average prices for calendar week ended Sept. 5, 1931, are Copper, 7.275c.; Straits tin, 26.525c.; New York lead, 4.400c.; St. Louis lead, 4.225c.; Zinc, 3.800c.; Silver, 27.625c.

Silver, Gold and Sterling Exchange

Aug.	Sterling Exchange "Checks"	Silver		Gold London	Aug. Sept.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
20	4.85 3/8	27 1/4	12 11/16	84s 11 3/8d	31	4.85 9/16	27 5/8	12 7/8	84s 10d
21	4.85 1/2	27 3/8	12 13/16	84s 11 3/8d	1	4.85 9/16	27 5/8	12 7/8	84s 10 3/4d
22	4.85 1/2	27 3/8	12 13/16	.....	2	4.85 9/16	27 1/2	12 13/16	84s 9 3/4d
24	4.85 3/8	27 7/8	12 15/16	84s 11 3/8d	3	4.85 5/8	27 5/8	12 7/8	84s 9 3/4d
25	4.85 5/16	27 5/8	12 7/8	84s 11 1/2d	4	4.85 1/2	27 5/8	12 7/8	84s 9 3/4d
26	4.85 1/4	27 3/4	12 15/16	84s 11 1/2d	5	4.85 1/2	27 3/4	12 15/16	.....
27	4.85 1/2	27 3/4	13	84s 11 1/4d	7	Holiday	Holiday	13	84s 9 3/4d
28	4.85 7/16	27 5/8	12 15/16	84s 11d	8	4.85 3/8	27 5/8	12 15/16	84s 11 1/2d
29	4.85 7/8	27 1/2	12 13/16	.....	9	4.85 1/2	28	13	84s 9 3/4d

Average for week ended Aug. 26: Silver, 27.542c.; Sterling Exchange, $4.85469.
Average for week ended Sept. 2: Silver, 27.604c.; Sterling Exchange, $4.85583.
Average for week ended Sept. 9: Silver, 27.725c.; Sterling Exchange, $4.85500.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables commanded thirteen thirty-seconds of a cent premium on Sept. 8, 1931.

London

Aug. Sept.	Copper Standard		Electrolytic	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3 M	Spot	3 M
20	32 1/4	33 1/8	35 1/2	115 1/8	117 5/8	11 13/16	11 15/16	11 15/16	12 9/16
21	32 3/8	33 1/4	35 1/2	115 5/8	118 1/4	12	12	11 15/16	12 5/16
24	32 5/8	33 1/2	35 1/2	114 1/2	117	11 15/16	11 15/16	11 7/16	12 1/8
25	32 1/2	33 5/16	35 1/2	116 7/8	119 1/2	11 15/16	11 7/8	11 9/16	12 1/8
26	32 7/16	33 5/16	35 1/2	119 1/2	122	12 3/16	11 15/16	11 5/8	12 5/16
27	32 11/16	33 9/16	35 1/2	121	123 1/2	12 1/4	12	12 1/16	12 3/8
28	32 11/16	33 9/16	35 1/2	120	122 1/2	12 1/8	11 7/8	11 13/16	12 3/16
31	33	33 7/8	36 1/4	121	123 5/8	12	11 3/4	11 9/16	11 15/16
1	32 7/8	33 13/16	36	120	122 1/2	11 5/16	11 1/2	11 1/2	12 1/16
2	32 13/16	33 3/4	35 3/4	118 1/4	120 3/4	11 1/16	11 1/4	11 7/16	12
3	32 1/2	33 5/16	36	117 1/2	120	11 1/16	11 1/4	11 1/8	11 11/16
4	32 3/16	33	35	115 3/8	117 7/8	10 15/16	11 1/16	11	11 9/16
7	31 1/2	32 3/8	35	115	117 1/2	10 15/16	11 1/16	11 1/8	11 11/16
8	31 5/16	32 3/16	35	114 1/2	117 1/8	10 7/8	11	11 1/16	11 9/16
9	30 9/16	31 5/8	34 1/2	113 7/8	116 3/8	10 11/16	10 13/16	10 3/4	11 1/4

Prices for lead and zinc are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

ANTIMONY — Per lb., duty paid, Chinese, slightly easier at 6.50@6.60c. for spot; futures, 6.375@6.50c.

MAGNESIUM—The principal producer has made a radical downward revision in price to stimulate consumption. Per lb., ingots (4x16 in.), 99½ per cent, 30c. in carloads, 32c. in 100-lb. lots or more, l.c.l.; in ⅜-, ½-, 1-, and 2-lb. sticks, 5c. per lb. over ingot price; 1/10- and ¼-lb. sticks, 8c. per lb. extra.

QUICKSILVER—Per 76-lb. flask, $75@$80. Demand has been very dull indeed, and to attract business, sellers have been willing to let round lots go as low as $75. Market seems weak.

RUTHENIUM—Slightly easier at $38@$42 per oz.

Metallic Ores

Prices in tons of 2,000 lb. or in "units" of 20 lb. unless otherwise stated.

Prices are quotably unchanged from the last issue on ores of antimony, beryllium, iron, molybdenum, tantalum, tin, titanium, tungsten, vanadium, and zircon.

CHROME ORE—Indian ores, 46@48 per cent Cr_2O_3, $17.50 per long ton unit, c.i.f. Atlantic ports.

MANGANESE ORE — Slightly lower prices are quoted on some grades, as follows, though the market is exceedingly dull and prices are largely nominal. Per long ton unit of Mn, ci.f. North Atlantic ports, cargo lots, exclusive of duty: Caucasian, 52@55 per cent, 26c. South African, 52@54 per cent, 23@25c.; 50@52 per cent, 22@24c.; 44@46 per cent, 21½c.

Chemical grades, powdered, coarse, or fine, minimum 80 per cent MnO_2, Brazilian or Cuban, per ton in carload lots: $50, or $60 if barreled. Javan or Caucasian, 85 per cent minimum, $50@$60. Domestic, 70@72 per cent, $50 in carloads, f.o.b. mines.

Non-Metallic Minerals

Prices are unchanged from the last issue except on the following:

BARIUM CARBONATE (Witherite)—Per ton, 80 per cent 300 mesh, $42; 100 mesh, $39.

GILSONITE — Per ton, carload lots, f.o.b. Colorado: brilliant black, $32.90.

MICA—Per lb., f.o.b. North Carolina: Punch, 3@5c.; 1½x2 in., 20@30c.; 2x2, 30@50c.; 2x3, 60@90c., 3x3, $1@$1.40; 3x4, $1.40@$1.80; 3x5, $1.50@$2; 4x6, $2.25@$3; 6x8, $2.50@$3.75; 8x10, $5@$7.50.

Other Commodities

Prices on metallic compounds, refractories, alloys, rolled metals, iron, steel, and coke, are unchanged from those given in the Aug. 24 issue except that, effective Sept. 10, brass and nickel-silver fabricated sheets, wire, and rods were reduced ⅛c. per lb., and bronze and copper, ¼c. This follows the reduction in export copper prices.

Metal Statistics

Monthly Average Prices of Metals

(See daily price table for basis of quoting)

Silver

	New York		London Spot		Sterling Exchange	
	1930	1931	1930	1931	1930	1931
January	45.000	29.423	20.896	13.810	486.447	485.260
February	43.193	26.773	20.008	12.432	485.784	485.551
March	41.654	29.192	19.298	13.524	485.933	485.595
April	42.428	28.279	19.554	13.120	486.019	485.76
May	40.736	27.650	18.850	12.858	485.724	486.188
June	34.595	27.250	16.049	12.707	485.625	486.291
July	34.346	28.255	15.928	13.197	486.300 (a)	485.349
August	35.192	27.524	16.283	12.815	486.839	485.284
September	36.315	.....	16.738	.....	485.888	.....
October	35.846	.....	16.563	.....	485.719	.....
November	35.908	.....	16.625	.....	485.454	.....
December	32.635	.....	15.201	.....	485.413	.....
Year	38.154	.....	17.666	.....	485.929	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.
(a) Revised.

Copper

	F.O.B. Refinery Electrolytic		London Spot Standard		London Spot Electrolytic	
	1930	1931	1930	1931	1930	1931
January	17.775	9.838	71.469	44.938	83.250	47.524
February	17.775	9.724	71.419	45.372	83.500	47.950
March	17.775	9.854	69.202	44.818	83.405	47.699
April	15.621	9.392	62.075	42.694	74.338	45.375
May	12.756	8.665	53.159	38.897	59.545	42.175
June	12.049	8.025	50.003	35.827	56.750	38.966
July	11.023	7.698	48.277	34.402	52.522	37.293
August	10.693	7.292	47.525	32.572	50.725	35.388
September	10.310	.....	46.264	.....	49.500	.....
October	9.597	.....	43.030	.....	45.772	.....
November	10.113	.....	46.134	.....	48.963	.....
December	10.300	.....	46.771	.....	50.065	.....
Year	12.982	.....	54.611	.....	61.528	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1930	1931	1930	1931	1930 Spot	1930 3 Mos.	1931 Spot	1931 3 Mos.
January	6.250	4.802	6.100	4.604	21.545	21.571	13.874	13.905
February	6.236	4.552	6.086	4.340	21.188	21.097	13.444	13.550
March	5.662	4.527	5.542	4.276	18.807	18.940	13.128	13.355
April	5.537	4.412	5.428	4.164	18.319	18.363	12.375	12.606
May	5.523	3.818	5.408	3.651	17.795	17.861	11.491	11.778
June	5.410	3.917	5.310	3.761	17.941	17.997	11.582	11.952
July	5.250	4.400	5.149	4.225	18.160	18.063	12.731	12.899
August	5.488	4.400	5.340	4.225	18.294	18.178	11.944	11.994
September	5.500	.....	5.348	.....	17.909	17.798	.....	.....
October	5.151	.....	4.999	.....	15.747	15.674	.....	.....
November	5.100	.....	4.950	.....	15.954	15.931	.....	.....
December	5.100	.....	4.950	.....	15.283	15.292	.....	.....
Year	5.517	.....	5.384	.....	18.077	18.064	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin and Cadmium

	New York		London		Cadmium
	1930	1931	1930	1931	1931
	Straits		Spot		
January	38.851	26.137	175.466	115.798	67.115
February	38.675	26.315	173.750	117.919	55.000
March	36.798	27.065	164.851	121.852	55.000
April	36.077	25.222	162.638	112.775	55.000
May	32.100	23.221	144.818	104.331	55.000
June	30.336	23.478	136.300	104.966	55.000
July	29.822	24.978	134.511	111.478	55.000
August	30.044	25.738	134.988	114.875	55.000
September	29.647	.....	132.631	.....	.....
October	26.802	.....	117.451	.....	.....
November	25.904	.....	113.519	.....	.....
December	25.262	.....	111.560	.....	.....
Year	31.694	.....	141.873	.....	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1930	1931	1930 Spot	1930 3 Mos.	1931 Spot	1931 3 Mos.
January	5.229	4.035	19.634	20.241	12.747	13.113
February	5.180	4.012	19.209	19.778	12.303	12.694
March	4.934	4.002	18.304	18.810	12.190	12.676
April	4.843	3.717	17.819	18.378	11.353	11.838
May	4.641	3.306	16.639	17.330	10.484	10.875
June	4.441	3.416	16.422	17.038	11.270	11.750
July	4.350	3.893	16.171	16.777	12.280	12.802
August	4.360	3.817	15.953	16.469	11.444	12.028
September	4.270	.....	15.773	16.080	.....	.....
October	4.050	.....	14.446	14.935	.....	.....
November	4.266	.....	14.706	15.238	.....	.....
December	4.099	.....	13.762	14.214	.....	.....
Year	4.556	.....	16.570	17.107	.....	.....

St. Louis quotations, cents per pound. London pounds sterling, per long ton

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1930	1931	1930	1931	1930	1931
January	8.606	7.317	121.192	103.000	61.923	36.000
February	8.830	7.069	120.500	100.205	59.909	34.000
March	8.236	7.127	118.808	100.423	54.769	29.538
April	7.740	6.888	114.000	102.077	46.462	26.346
May	7.454	6.524	117.269	101.140	46.000	24.980
June	7.057	6.342	118.600	92.058	46.000	37.115
July	6.976	6.802	117.462	85.808	43.692	40.000
August	7.839	6.596	116.000	80.115	41.462	40.000
September	7.773	.....	113.620	.....	36.080	.....
October	7.288	.....	110.596	.....	36.000	.....
November	7.105	.....	106.717	.....	36.000	.....
December	7.099	.....	105.346	.....	36.000	.....
Year	7.667	.....	115.009	.....	45.358	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce.

Pig Iron[1] and Aluminum

	Bessemer		Basic		No. 2 Foundry		Aluminum	
	1930	1931	1930	1931	1930	1931	1930	1931
January	19.00	17.50	18.50	17.00	18.50	17.00	24.300	23.300
February	19.00	17.29	18.50	16.79	18.50	16.79	24.300	23.300
March	19.00	17.00	18.50	16.50	18.50	16.50	24.300	23.300
April	19.00	17.00	18.50	16.50	18.50	16.50	24.300	23.300
May	19.00	17.00	18.50	16.38	18.50	16.44	24.300	23.300
June	19.00	17.00	18.50	15.50	18.50	16.00	24.140	23.300
July	18.62	17.00	18.12	15.50	18.12	16.00	23.300	23.300
August	18.50	17.00	18.00	15.50	18.00	16.00	23.300	23.300
September	18.38	.....	17.76	.....	17.88	.....	23.300	.....
October	17.85	.....	17.00	.....	17.22	.....	23.300	.....
November	17.50	.....	17.00	.....	17.00	.....	23.300	.....
December	17.50	.....	17.00	.....	17.00	.....	23.300	.....
Year	18.53	.....	17.99	.....	18.02	.....	23.787	.....

Iron in dollars per long ton. Aluminum in cents per pound, 99 per cent grade.
[1]F.o.b. Mahoning and Shenango Valley furnaces; freight to Pittsburgh, $1.76

Monthly Crude Copper Output in Short Tons

	1929	1930	1931 April	1931 May	1931 June	1931 July
Domestic						
Alaska shipments	21,947	18,953	885	1,215	1,303	1,048
Calumet & Arizona	65,246	45,161	.....	.....	.....	.....
Magma	19,118	15,940	1,213	1,208	1,437	1,229
Miami	29,567	34,568	1,998	2,272	2,174	2,032
Nevada Consolidated	133,140	70,990	.....	.....	(d) 16,504	.....
Old Dominion (a)	11,172	10,428	587	992	600	575
Phelps Dodge (b)	111,026	72,308	5,180	5,176	5,178	5,179
United Verde Extension	29,669	21,908	1,537	1,685	1,642	.....
Tennessee Corporation	7,876	7,772	609	992	833	747
Foreign						
Andes Copper	60,538	47,428	3,503	3,498	3,498	.....
Braden	88,155	79,923	8,597	8,594	8,593	.....
Boleo, Mexico	12,898	13,940	.....	.....	(d) 3,107	.....
Chile	(c) 150,247	89,100	7,121	7,117	7,122	.....
Furukawa, Japan	17,767	18,536	1,624	1,517	1,505	.....
Howe Sound	21,516	22,633	.....	.....	(d) 4,001	.....
Messina	(c) 7,100	(c) 7,600	764	868	870	832
Mt. Lyell	9,731	10,878	.....	.....	.....	.....
Sumitomo, Japan	20,180	15,429	1,236	1,571	1,286	1,255

(a) Includes Arizona Commercial. (b) Moctezuma is included. (c) Fiscal year. (d) Three months.

Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

	1929 Monthly Production	1929 Daily Rate	1930 Monthly Production	1930 Daily Rate	1931 Monthly Production	1931 Daily Rate
January	86,324	2,785	67,838	2,188	48,059	1,550
February	84,735	3,026	59,196	2,144	47,504	1,697
March	93,698	3,023	61,216	1,975	48,702	1,571
April	94,902	3,163	60,450	2,015	46,452	1,548
May	93,392	3,013	60,238	1,943	45,580	1,470
June	82,354	2,745	56,743	1,891	44,473	1,482
July	79,229	2,556	54,249	1,750	38,606	1,245
August	78,885	2,545	56,779	1,832	.....	.....
September	79,402	2,647	56,584	1,886	.....	.....
October	82,575	2,664	55,954	1,805	.....	.....
November	75,934	2,531	53,141	1,771	.....	.....
December	74,772	2,412	48,518	1,565	.....	.....
Total	1,006,203	.....	690,263	.....	319,376	.....
Monthly average	83,850	.....	57,522	.....	45,625	.....
Av. of daily rate	.....	2,757	.....	1,891	.....	1,506

Mining Share Prices—Month of August, 1931

Company Name	High	Low	Last	§Most Recent Dividend
NEW YORK STOCK EXCHANGE				
Alaska Juneau	0.18⅛	0.14⅜	0.17½	Jy. 10, Au. 1, 1931....Q 0.10
American Metal	12	10	11½	December, 1930.....Q 0.25
Am. Metal, pfd	58½	58½	58½	Au. 22, Se. 1, 1931....Q 1.50
Am. Sm. & Ref	32⅜	29⅜	31⅜	Jy. 10, Au. 1, 1931....Q 0.50
Am. Sm. & Ref. 2nd pfd.	92	85	85	Au. 7, Se. 1, 1931....Q 1.50
Am. Sm. & Ref. 1st pfd.	127	123⅜	123⅜	Au. 7, Se. 1, 1931....Q 1.75
Am. Zinc, L. & S	5.50	4.87½	5.00	May, 1917 1.00
Am. Zinc, L. & S., pfd.	45½	45½	45½	October, 1930.....Q 1.50
Anaconda	25¾	23¼	25⅜	Jy. 11, Au. 17, 1931....Q 0.37½
Andes Copper	.....	.....	12*	Ja. 10, Fe. 9, 1931....Q 0.25
Butte C. & Z	1.00	1.00	1.00	December, 1929 0.50
Butte & Superior	2.00	1.62½	1.62½	December, 1929.....Q 0.50
Callahan Zinc-Lead	0.62½	0.50	0.50	December, 1920 0.50
Cal. & Arizona	38⅜	36⅛	38	June, 1930 0.50
Cal. & Hecla	6.87½	6.12½	6.12½	June, 1930 0.50
Cerro de Pasco Copper	16½	15	15½	Jy. 16, Au. 1, 1931....Q 0.25
Dome Mines	12¼	11⅛	12¼	Je. 30, Jy. 20, 1931....Q 0.25
Federal M. & S	.....	.....	42*	June, 1927 10.00
Federal M. & S., pfd	.....	.....	75*	My. 25, Je. 5, 1931....Q 1.75
Freeport Texas	27⅞	25	27	My. 15, Je. 1, 1931....Q 0.75
Granby Con	12⅜	11	11	Jy. 17, Au. 1, 1931....Q 0.25
Greene Cananea	.....	.....	73½*	July, 1930 0.75
Homestake	100	98½	98½	Au. 20, Au. 25, 1931...MO 0.50
Howe Sound	19½	18½	19½	Je. 30, Jy. 15, 1931....Q 0.50
Inspiration	7.12½	6.00	6.37½	July, 1930 0.50
International Nickel	14	12	13⅜	Au. 31, Se. 30, 1931...Q 0.10
Int. Nickel, pfd	118⅜	117⅜	118⅜	Jy. 2, Au. 1, 1931....Q 1.75
Kennecott Copper	18⅛	16⅜	17⅜	Je. 11, Jy. 1, 1931....Q 0.25
McIntyre Porcupine	22	21	21⅜	Au. 1, Se. 1, 1931....Q 0.25
Magma Copper	14	13	13⅜	Je. 30, Jy. 15, 1931....Q 0.25
Miami Copper	6.25	5.25	5.25	August, 1930 0.375
Mother Lode	0.50	0.37½	0.37½	June, 1930 0.10
National Lead	.....	.....	104*	Se. 11, Se. 30, 1931....Q 1.25
National Lead, pfd A	140	138¼	138¼	Au. 28, Se. 15, 1931....Q 1.75
National Lead, pfd. B	118	118	118	Oc. 16, No. 2, 1931....Q 1.50
Nevada Con	9.25	7.87½	8.25	Je. 12, Je. 30, 1931....Q 0.25
Noranda Mines	20⅜	17⅜	20⅛	October, 1930 0.50
Park Utah Con	1.25	1.12½	1.12½	July, 1929.....Q 0.20
Patiño M. & E	11	8.00	10⅛	December, 1929 4s.
Phelps Dodge	12½	11⅜	11⅜	Je. 18, Jy. 1, 1931....Q 0.25
Rand Mines	.....	.....	30*	August, 1930 1.52
St. Joseph Lead	17	15¾	15¾	Se. 10, Se. 21, 1931....Q 0.25
Seneca Copper	1.00	0.62½	0.75	.....
Tennessee Corp	5.50	5.00	5.25	Fe. 28, Mh. 16, 1931...Q 0.125
Texas Gulf Sulphur	35⅛	33⅛	35⅛	Se. 1, Se. 15, 1931....Q 0.75
U. S. S. R. & M	16½	15	16	Jy. 2, Jy. 15, 1931....Q 0.25
U. S. S. R. & M., pfd	42	37⅛	37⅛	Jy. 2, Jy. 15, 1931....Q 0.87½
Utah Copper	.....	.....	100*	Je. 12, Je. 30, 1931....Q 1.50
Vanadium Corp	29¼	24¼	28¼	Fe. 2, Fe. 16, 1931....Q 0.75
NEW YORK CURB EXCHANGE				
Aluminum Co. of Am	135	112½	131½	.....
Alum. Co. of Am., pf	101	99	99	Mr. 14, Ap. 1, 1931....Q 1.50
Anglo-Chilean Con	1.75	0.87½	1.00	4 shares Cosach B...June, 1931
Bunker H. & S	37	35	35	My. 29, Je. 5, 1931.....0.25
Carnegie Metals	.....	.....	1.12½*	.....
Comstock Tunnel	0.62½	0.37½	0.50	.....
Con. Coppermines	2.25	2.00	2.00	.....
Copper Range	.....	.....	5.00*	July, 1930 0.25
Cresson Consolidated	0.43⅜	0.37½	0.37½	Je. 30, Jy. 10, 1931....Q 0.01
Cusi Mexicana	0.37½	0.25	0.37½	.....
Evans-Wallower	0.75	0.56¼	0.75	.....
Federated Metals	8.12½	8.00	8.00	Ja. 5, Ja. 15, 1931....Q 0.25
Hecla Mining	5.50	5.37½	5.37½	Au. 15, Se. 1, 1931....Q 0.10
Hollinger Consolidated	6.25	6.00	6.12½	Au. 26, Se. 9, 1931.....M 0.05
Hudson Bay M. & S	4.12½	3.75	3.87½	.....
Iron Cap Copper	.....	.....	0.75*	.....
Mayflower Associates	31	30	30	Se. 1, Se. 15, 1931....Q 0.50
Mining Corporation	1.75	1.75	1.75	December, 1929 0.12½
New Jersey Zinc	38⅜	35½	35½	Jy. 20, Au. 10, 1931....Q 0.50
Newmont Mining	28	25½	28	Mh. 31, Ap. 15, 1931..Q 1.00
N. Y. & Honduras Ros	10½	10⅛	10⅜	Jy. 21, Jy. 31, 1931....Q 0.25
Nipissing	1.50	0.87½	1.50	Mh. 31, Ap. 20, 1931..Q 0.075
Ohio Copper	0.18⅜	0.12½	0.12½	September, 1926 0.03
Premier Gold	0.62½	0.50	0.56¼	Je. 11, Jy. 3, 1931....Q 0.03
Quincy	.....	.....	4.87½*	March, 1920 1.00
Shattuck Denn	3.50	3.37½	3.50	.....
So. Am. Gold & Plat	1.25	1.12½	1.25	.....
Teck-Hughes	6.50	6.12½	6.25	Jy. 18, Au. 1, 1931....Q 0.15
Tonopah Mining	.....	.....	0.50*	October, 1929 0.07½
United Eastern	.....	.....	0.06¼	.....
United Verde Ex	10	7⅞	8⅛	Jy. 2, Au. 1, 1931....Q 0.25
Utah-Apex	.....	.....	1.00*	December, 1929 0.02
Yukon Gold	.....	.....	0.12½*	June, 1918 0.02
BOSTON STOCK EXCHANGE				
Isle Royale	3.00	2.50	3.00	March, 1930 0.50
Mohawk Mining	16	15½	16	Jy. 31, Au. 29, 1931....Q 0.25
Old Dominion	2.43¾	2.00	2.12½	December, 1918 1.00
Utah Met. & Tunnel	0.40	0.35	0.40	December, 1927 0.30
MONTREAL				
Asbestos Corp	0.30	0.30	0.30	January, 1926 1.50
Asbestos Corp., pfd	0.50	0.50	0.50	January, 1930 1.75†
Consolidated M. & S	98½	90	95	Je. 23, Jy. 15‡1931....SA 1.25

Company Name	High	Low	Last	§Most Recent Dividend
SPOKANE				
Constitution	.....	.....	0.06¼*	.....
Dayrock	.....	.....	0.95*	March, 1930 0.03
Golconda	0.23	0.20	0.21½	July, 1929 0.02
Jack Waite Con	0.35	0.30½	0.30½	.....
Los Lugos	.....	.....	0.01½*	.....
Mexican Premier	0.18	0.15¼	0.18	January, 1930 0.01
Montana Mines	0.10	0.08	0.09	.....
Noble Five	.....	.....	0.03*	January, 1930 0.005
Pend Oreille	.....	.....	0.65*	.....
Sherman Lead	0.31	0.31	0.31	March, 1930 0.01
Sidney	.....	.....	0.05*	October, 1929 0.01
Sunshine Mining	0.92	0.83½	0.83½	December 20, 1930.....Q 0.03
Tamarack & Custer	0.17½	0.17½	0.17½	September, 1924 0.25
SALT LAKE CITY				
Chief Con	0.45	0.40½	0.45	February, 1928 0.10
Combined Metals	0.07⅝	0.07⅝	0.07½	.....
Eureka Bullion	0.21½	0.17	0.20	.....
Eureka Lilly	.....	.....	0.12½*	.....
Moscow Silver	0.40	0.35	0.35	.....
New Quincy	0.14½	0.11	0.14½	September, 1929.....Q 0.10
North Lily	0.02½	0.02½	0.02½	January, 1930 0.15
Park Bingham	0.79	0.71	0.79	.....
Park City Con	0.16	0.13½	0.13½	.....
Rico Argentine	0.04	0.04	0.04	December, 1929 0.03
Silver King Coalition	4.75	4.50	4.75	De. 20, Ja. 2, 1931....Q 0.15
Tintic Lead	0.95	0.68	0.70	.....
Tintic Standard	3.50	3.30	3.30	Je. 20, Je. 30, 1931....Q 0.10
Walker Mining	1.17½	1.10	1.12½	April, 1930 0.075
TORONTO				
Abana Mines	0.06	0.03	0.04½	.....
Amulet Mines	0.19	0.15½	0.19	.....
Base Metals	0.13½	0.08	0.12½	.....
Barry-Hollinger	1.05	0.99	1.01	.....
Canam Metals	.....	.....	0.03*	.....
Castle-Trethewey	0.16	0.15	0.15	.....
Central Manitoba	0.12	0.09½	0.10	.....
Falconbridge	1.15	1.00	1.06	.....
Granada Rouyn	1.74	1.10	1.21	.....
Howey Mines	0.40	0.30	0.34	.....
Keeley	0.25	0.23	0.25	March, 1928 0.04
Kirkland Lake	0.71	0.55	0.63½	.....
Lake Shore	28½	26½	27½	Je. 1, Je. 15, 1931....QB 0.60
Sherritt Gordon	0.63	0.54	0.60	.....
Siscoe Gold	0.57	0.46	0.56	.....
Sylvanite	0.79	0.65	0.76	De. 5, De. 20, 1930...SA 0.02
Treadwell Yukon	1.55	1.25	1.25	.....
Ventures	0.76	0.40	0.65	.....
Vipond Con	0.73½	0.67	0.69½	April, 1927 0.03
Waite-A.-M	1.10	1.00	1.00	.....
Wright-Hargreaves	3.24	2.75	3.13	Je. 15, Je. 30, 1931.....Q 0.05
ST. LOUIS, CINCINNATI, AND DENVER				
Consolidated L. & Z	.....	.....	2.00*	December, 1929 0.125
Eagle-Picher	5.62½	5.25	5.62½	April, 1930 0.20
Eagle-Picher, pfd	.....	.....	89*	De. 31, Ja. 15, 1931....Q 1.50
Empire Chief	0.00¾	0.00¾	0.00¾	.....
Star of Utah	0.24	0.20	0.24	.....
Tungsten Prod	0.06	0.06	0.06	.....
West Gold	.....	.....	0.37½*	.....
SAN FRANCISCO, LOS ANGELES, AND COLORADO SPRINGS				
California Copper	0.50	0.37½	0.50	.....
(a)Golden Cycle	14	13¾	13¾	Au. 31, Se. 10, 1931.....Q 0.40
(a)Granite Gold	0.20	0.18	0.18	Je. 22, Jy. 1, 1931.....Q 0.01
Idaho-Maryland	0.61½	0.52	0.55½	.....
Tom Reed	0.76	0.60	0.65	Je. 10, Jy. 1, 1931.....Q 0.01
(a)United Gold	0.07½	0.07	0.07	February, 1930.....0.01

‡LONDON

Company Name	High	Low	Last	Most Recent Dividend (Per Cent, Unless Noted)
Anglo American	12/3	10/9	11/3	22½, Feb. 19, 1930
Aramayo Mines	19/–	18/6	18/9	5, Oct. 23, 1929
Burma Corporation	7/6	6/4½	6/9	1¼, Dec. 10, 1930(b)
Camp Bird	3d.	1½d.	3d.	16¼, April 25, 1928
Fresnillo	.....	.....	8/9*	25 cents, Feb. 12, 1930
Frontino & Bolivia	.....	.....	11/3*	2½, July 1, 1931
Lake View & Star	8/9	7/9	8/4½	11½, 1921
Mexican Corporation	3/9	3/6	3/9	10, Oct. 24, 1929
Oroville Dredging	1/3	1/3	1/3	37½, May 16, 1930
Rhokana Corporation	80/–	70/–	70/–	.....
Rhodes.-Select. Trust	10/–	8/9	9/4½	.....
Rio Tinto	358/9	320/5	347/6	10s, May 1, 1931
St. John del Rey	18/3	17/9	18/3	8¾, May 1, 1931
San Francisco Mines	10/6	9/–	9/6	10, Jan. 7, 1931
Santa Gertrudis	7/–	6/–	6/9	9d., July 9, 1931
Selukwe	2/–	1/9	1/9	6¼, April 2, 1917
So. American Copper	1/6	1/3	1/3	.....
Tanganyika	20/–	18/3	18/9	2½, Aug. 2, 1930
Wiluna Gold	15/–	6/3	6/6	.....
Union Minière	4,425	4,125	4,125†	240 francs, July, 1931

Salt Lake Stock Exchange courtesy J. A. Hogle & Company, Spokane Standard Exchange courtesy the Pohlman Investment Company. *Not traded in. †Belgian Francs. ‡The above London quotations are for the month ended Aug. 24. Q, quarterly; I, initial; M, monthly; X, extra; SA, semi-annual; L, liquidating B, plus bonus. §Total dividends paid during the month will be found tabulated in the Market and Financial News Section. Dates here given are those of closing of books and payment of dividend. (a) Bid prices. (b) 1¼% (2 annas) dividend, and bonus of ¼% (1 anna). (c) Closing bid prices.